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THE GROSS AND NET EARNINGS OF RAILWAYS in the United States for the month of August and the first eight months of 1891 are as follows, according to the *Financial Chronicle*:

	August. (137 roads.)		Jan. 1 to Aug. 31. (121 roads.)	
	1891.	1890.	1891.	1890.
Gross earn.	$37,474,852	$59,542,861	$419,607,120	$406,53 1 088
Oper. exp.	39,963,882	38,209,083	287,685,510	281,917,212
Net earn	$22,510,970	$21,331,778	$131,315,604	$124,621,876

This is an increase in gross of 4.92% for the month and of 3.06% for the eight months, and an increase in net of 5.52% for the month and 5.37% for the eight months. Considering the earnings of the various roads separately, the figures show considerable irregularity in the results of operations. A few of the larger systems show remarkably heavy gains, but the larger number of roads show losses, or, at best, very small gains. Considered by groups, the Southern and Pacific roads show the best results in net for the eight months and the Northwestern and Eastern and Middle lines for the month of August.

A NICKEL-STEEL INGOT, weighing more than 25 tons, has been successfully cast at the Homestead steel works. It is to be rolled into a single armor-plate for the monitor *Monterey*. This is the largest plate yet cast at this mill; but experiments are shortly to be made on a 50-ton ingot. The 12-in. tube, for the first American made 12-in. gun, has been turned out at Bethlehem, and is now in the lathe at Watervliet gun foundry.

PORTABLE JETTIES are proposed by Mr. GRANT MARSH, of St. Louis, Mo. In a news article he describes these as iron or wooden barges, flat bottomed, pointed at both ends, decked and provided with water tight compartments. For cutting a channel through a shallow bar, he proposes to sink these in two parallel or diverging lines by admitting water. And he believes that in the case of a break in a levee one or more of these barges sunk outside of the break would stop the cutting and allow the break to be readily mended. They can be lifted by pumping out the water and used again. He is now applying to the Government for an appropriation of $300,000 to build six of these portable jetties. The matter will be discussed at the Waterways Convention to be held shortly at Evansville.

TERRESTIAL MAGNETISM AND SOLAR PHYSICS in their relation to meteorology, is to be made the work of a special department in the Weather Bureau. Prof. FRANK H. BIGELOW, late assistant in the "Nautical Almanac" office, will be in charge. Prof. BIGELOW's recent discoveries regarding the solar corona and terrestrial magnetism especially fit him for this post.

AN ARTESIAN WELL, 3,095 ft. deep, is reported as having been successfully sunk by Mr. S. SWANSON for the Ashland (Wis.) Iron & Steel Co. The well was begun June 8, 1890, and completed Sept. 29, 1891, at a cost of over $14,000. After the first 175 ft. the remainder of the well, it is said, passes through brown sandstone. Water rises to the surface.

PULLMAN PALACE CAR CO'S STOCK has been increased by an issue of $5,000,000 of additional stock authorized at a meeting of stockholders held in Chicago Oct. 15. The total of stock will now be $30,000,000. The present Chicago price of the stock is 193, and the revenue for the last year was $9,772,324 and the expenditures $6,783,101.

THE NATIONAL HEAT & POWER CO., of Philadelphia, has been experimenting during the last two years at the Bellefonte Iron & Nail Company's mill, at Bellefonte, Pa., in puddling iron with fuel gas made by the Rose process, with very satisfactory results, according to the *Iron Age*. The gas burned, including that used in keeping the furnace hot between turns (the mill only running double turn) averages 19,600 ft. per ton of iron. One heat (1,080 lbs.) was puddled with 5,230 ft. of gas, and several heats with less than 8,000 ft. each. The cost of gas per M. ft., with coal at $1.56, coke at $2.25 per ton, and oil at 2¼ cts. per gall., was 6⅝ cts. With fuel at Pittsburg prices it can be produced for 5 cts. per M. ft., thus bringing the cost of puddling down to $1 per ton. The Carnegie works have secured the right to use Rose process in all of their mills after a 5 weeks' test, and have ordered a plant with a capacity of running 6 puddling furnaces to be erected in their Upper Union Mills, at Pittsburg, at once, upon the completion of which they will give it a thorough test in puddling and heating with a view of adopting it for use in all their furnaces.

THE CHICAGO WORLD'S FAIR TOWER PROJECT is assuming shape. The Keystone Bridge Co., of Pittsburg, Pa., has agreed in writing to erect the metal work and have it completed by Feb. 1, 1893, under a heavy forfeit, or a bonus if finished by Oct. 12, 1892. The tower is designed by the well known engineer, Mr. GEORGE S. MORISON, of Chicago. It would be 1,120 ft. high and 440 ft. in diameter at the foundation level. The three landings will be circular and 200, 150 and 60 ft. in diameter, and 200, 400 and 1,000 ft. from the ground. Two elevators, out of the number used, will run without stop to the highest platform, and the tower will accommodate 25,000 people at one time, with 6,000 to 8,000 people comfortably seated in the restaurants. It will contain four hotels, besides restaurants, shops, promenade colonnade, &c. The "lantern" is to be surmounted by offices for the signal service and scientific observation, a circular electric railway carrying lights at night and signals by day, and above all one of the most powerful revolving lights ever constructed. The actual cost is estimated at $1,500,000, and the earning capacity about four times that of the Eiffel tower in Paris, which cost $1,700,000.

RAPID TRANSIT IN PHILADELPHIA is promised at an early date by Mr. F. B. ESLER, president of the Northeastern Elevated Railway Co. Though no formal contract has yet been signed Mr. ESLER says the Phœnix Bridge Co. will build the first 1½ miles of this road. The bridge company declines to confirm this statement, says the Philadelphia *Press*.

GRAVEL VS. SAND OR ROTTEN ROCK, for pavement foundations, is a subject of interest to Philadelphia and Germantown contractors, just now. Under the old form of specifications, still in use, gravel is called for, and Director of Public Works WINDRIM insists upon the letter of the contract. The defense of the contractors is that sand has been used for years under these same specifications, and as good gravel can only be obtained at a distance the use of the latter would add "25% to the bids for work." They also claim that the sand used makes a better and more solid foundation than the gravel available. Director WINDRIM, however, says that much of the "rotten rock" used contains mica in quantities and is thus objectionable. There is evidently a chance here for some investigation and a possible change in the form of specifications.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment Oct. 20 on the Chicago, Burlington & Quincy R. R., near Monmouth, Ill. A fast passenger train struck a split switch which was partly open, the engine taking the side track and the cars the main track. All the cars except a sleeping car were derailed and overturned. There were 4 persons killed and about 20 injured. The baggage car caught fire but the flames were soon extinguished. The switch is said to have been tampered with. A serious head collision between a passenger and freight train occurred Oct. 16 at Mingo Junction, O., on the Pittsburg, Cincinnati, Chicago & St. Louis R. R. The accident occurred at a signal station, and is attributed to a misplaced switch. The engines were wrecked, and the mail and baggage cars telescoped. The wreck caught fire and two men were burned to death. About 4 persons were injured. A serious derailment occurred Oct. 20 on the Baltimore & Ohio R. R at St. John's Station, Md., in which 2 persons were killed and 4 injured, 3 fatally. The track is said to have spread under a fast train, the engine, baggage car, mail, smoking, passenger and 2 sleeping cars all being derailed and upset.

A LOCOMOTIVE BOILER EXPLOSION occurred on the Philadephia & Reading R. R. near St. Clair, Pa., Oct. 19. A mountain engine was hauling a train of empty cars up the grade when the boiler exploded, killing 3 men. No cause is assigned for the explosion, the engine being just out of the shops.

A BRIDGE ACCIDENT occurred on the Memphis & Charleston R.R., Oct. 18. The north approach to the new draw over the Tennessee River at Florence, Ala., gave way under a heavy ore train. Six cars went down, but none of the trainmen were hurt.

THE STEAM HEATING OF CARS on the New York Central & Hudson River R. R. is explained as follows in a letter sent us by Mr. H. W. WEBB, Vice-President:

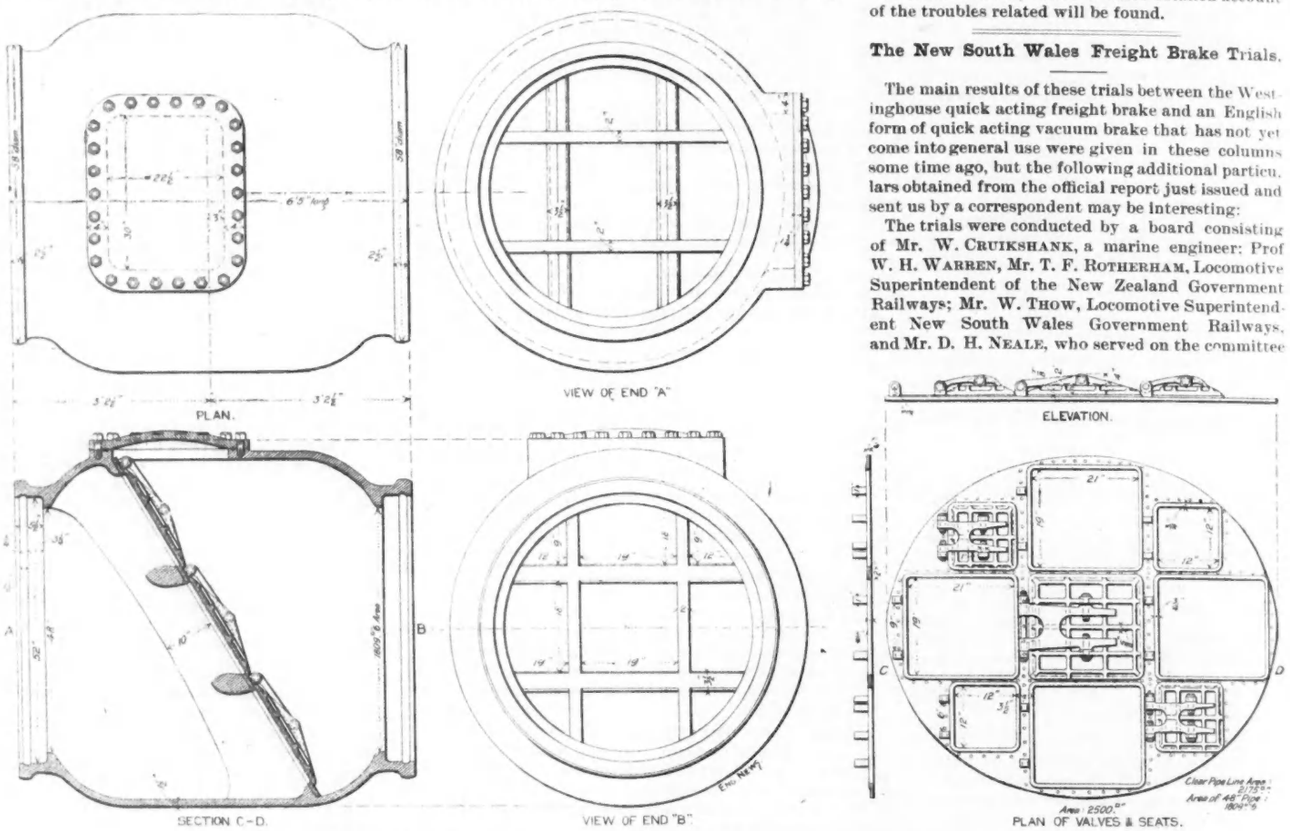
"In order that you may understand the case fully, I will state that the Martin Co. obtained an injunction against the New York Central, restraining it from using the Sewall couplers in connection with their system of heating inside of the coaches. We contested the case and obtained from the Supreme Court an order suspending the injunction for 60 days. We determined, under the circumstances, to substitute another system for the Martin system, for which the Consolidated Car Heating Co. were to furnish the apparatus and material, with the Sewall couplers. After this was made public the Martin Co., in a conference we had with its representative, discontinued its litigation and made an agreement with this road whereby we are at liberty to use what couplers we see fit in connection with the Martin system of heating by steam. Under these circumstances we shall not remove the Martin system, but will use it in connection with the Sewall couplers."

THE ASSOCIATION OF CIVIL ENGINEERS of the City of Mexico has voted to attend the World's Fair in Chicago in a body.

PIG IRON PRODUCTION is now at a considerably more rapid rate than in the first half of the year and at nearly as great a rate as at any time in 1890, when we produced 9,202,703 gross tons, against only 7,875,130 in Great Britain. The indications now are that the British output will be reduced to 7,700,000 tons less, or to reach which the output of the last half of 1891 will have to be larger than in 1890, since the first half shows a decrease of 355,677 tons. Our own output for the first half of 1891 was reduced very much more than this to 3,371,925 gross tons, but if we make 4,300,000 or thereabouts in the last half of this year we shall equal or exceed Great Britain. The indications are that the two outputs will be very nearly equal.

Forty-Eight-Inch Check Valve.

The 48-in. check valve shown by the accompanying illustration is on the 48-in. cast-iron force main leading from the Millburn pumping station to the Baldwin storage reservoir, in connection with the extension now being made to the Brooklyn, N. Y., water-works. The illustrations show a plan of the valve, another of the valve seats, two end elevations and a longitudinal section. By referring to the plan of the valves and seats it will be seen that there are four flaps 19 × 21 ins. and four 12 × 12 ins. The area of the pipe is 1,810 sq. ins., and the clear pipe line area is 2,175 sq. ins. The valve hinges are bolted to the valves at the center line, as shown in plan, thus saving strain at the joints in case any obstacle to shutting lodges on the seats. This valve was furnished by the Coffin Valve Co., Boston, Mass., as are all the others used on the extension.



FORTY-EIGHT-INCH CHECK VALVE, BROOKLYN WATER-WORKS EXTENSION.

Water Rights and Irrigation Development at Riverside, Cal.

The growth of Riverside, Cal., is an illustration of the development of the principle that in irrigation the ownership of land and water should be a common one. Years ago water was furnished by the Southern California Colony Co. Land owners were entirely at the mercy of this company, as it held that no one but itself had a right to the water available for irrigation. The development of Riverside was retarded, and finally a new company was formed, which bought out the old one, and announced as its policy the sale of water rights with the sale of land, in every case. Trouble arose between the new company, the Riverside Land & Irrigating Co., and settlers on government lands. It had been the custom for owners of such lands to give one-half their land to those who would put water upon it, but owing to the fact that this particular land was unpatented such an arrangement could not be made. The other land in the settlement had, it seems, been bought from the old company, and the new company now offered to sell to settlers on government land water at $20 per acre, which was said to be the price of the ditches. Some availed themselves of this offer, but others had recourse to the Legislature and secured the passage of a law to the effect that lands once under water, which had been permanently improved, should have a perpetual right to the use of water. It seems that this act did not put an end to the difficulties, especially as there was a feeling that the company was preparing to irrigate more land than it had water for. After a long struggle, during which a rival company seems to have been formed, the Riverside Water Co. was organized, and an agreement was made that government settlers who had not done so should pay $20 an acre for the same rights as other water users enjoyed. The new company was to receive all the property of the old except a one-half interest in 6,000 acres of dry land. The old company was to transfer this 3,000 acres of land to the Riverside Water Co., only on condition that every acre of the 6,000 entitled to water should be bonded for $20 to pay for the improvement of the canals and the development of water to irrigate the tract. The dry lands were to be managed by a land company and sold whenever the directors of the water company considered that there was sufficient water to irrigate them. Two directors of the land company were to be chosen by both the old and the new water companies, and these four were to choose a fifth. When water was put upon the land stock was to be issued by the land company to the old and new companies which would go with the sale of the land, but for the time would give the companies a majority of votes and enable them to elect such directors as they saw fit. Of course with the sale of the land by the land company the settlers would gradually acquire a majority of the stock. An attempt was made by some of the stockholders to secure a permanent injunction preventing the issuance of the stock and the supplying of water to the 6,000-acre tract held by the land company. The suit was not successful.

The above facts have been given in detail because they illustrate the legal and other difficulties which retard irrigation development, and show the necessity for more definite and careful legislation regarding water rights in our western states. In case the general government should cede the arid lands to the western states in trust, as the recent Salt Lake Irrigation Congress declared that it ought, then the opportunity should be embraced to provide for proper regulation of the water rights naturally pertaining to the ceded lands. Such regulations should be based on the experience and legislation of both foreign and American states.

We are indebted for the facts given above to Mr. T. W. BROOKS, San Francisco, Cal., and to the Riverside (Cal.) *Phœnix*, where a more detailed account of the troubles related will be found.

The New South Wales Freight Brake Trials.

The main results of these trials between the Westinghouse quick acting freight brake and an English form of quick acting vacuum brake that has not yet come into general use were given in these columns some time ago, but the following additional particulars obtained from the official report just issued and sent us by a correspondent may be interesting:

The trials were conducted by a board consisting of Mr. W. CRUIKSHANK, a marine engineer; Prof W. H. WARREN, Mr. T. F. ROTHERHAM, Locomotive Superintendent of the New Zealand Government Railways; Mr. W. THOW, Locomotive Superintendent New South Wales Government Railways, and Mr. D. H. NEALE, who served on the committee of the Master Car Builders' Association which conducted the Burlington brake trials. The latter gentleman submits an independent minority report. The four former gentlemen conclude their report as follows:

"The Vacuum Brake Co. claims that no risk is run with its brake from cocks being turned in the wrong direction, and as there are 150 cocks in a train of 50 vehicles fitted with the Westinghouse brake, a considerable amount of risk may be expected to arise from the misuse of these details at country stations where unskilled men have to couple and uncouple trains. . . Respecting the exhaustion theory, the test on the incline 30 miles long, falling 3,262 ft. with ruling grades of 160 ft. and a maximum grade of 176 ft. per mile, showed that with ordinary care the Westinghouse brake is practically safe and reliable on steep grades. The merits of each brake have been exhaustively tested in the experiments now completed. Both brakes are highly ingenious, efficient and reliable appliances for the purpose intended, and in the vacuum the superiority in graduating, simplicity in construction and probably economy in maintenance render it well suited for the goods stock of the New South Wales Railways."

The trains were not fitted with retaining valves, and it is, therefore, satisfactory to find that even in a report which is markedly hostile to the Westinghouse brake, it is acknowledged that it can control trains without retaining valves even on grades as steep as 160 and 176 ft. per mile. The diagrams attached to the report are somewhat imperfect, but show that the train pipe pressure in the Westinghouse was increased during the descent of grades 20 miles long, and that the train was well under control.

But an inspection of the diagrams, in conjunction with other portions of the majority report, fails to reveal to us a single fact indicating the alleged inferiority of the Westinghouse brake in graduating, while it abounds in evidence that the Westinghouse was far superior to the Vacuum in this respect. The following quotations from the same majority report deserve special notice:

"In the descent of the loaded vacuum train it is important to note that in descending the long incline the brakes on 12 of the 35 vehicles were found to be cold at the foot of the grade, although half the maximum brake pressure had been applied at various times for a distance of 26 miles."

"This *may* be due to the reasons given by the company's agent, viz: that in fitting up the train a number of the rubber rolling rings had been rendered comparatively useless for graduating through some of the railway mechanics inadvertently oiling the brake cylinders. This opinion is corroborated by the fact that in an emergency stop made a few minutes afterwards it was found all the brakes were fully applied."

"In the graduation tests down the long incline [the same incline referred to above] the vacuum had a decided advantage because the principles of its working insure perfect graduation both in putting brakes on and taking them off. This is clearly shown in coming down steep grades with empty and loaded trains, and this conclusion is clearly demonstrated by the diagrams which show in a very marked degree the superiority of the vacuum graduation."

The brake, it would seem from the above, "was superior in graduation," because it failed lamentably in graduating, though in perfect order, when tested by a full application! As this is the usual manner of testing in ordinary working, the train hands would have no warning at the summit of the incline that the brake could not be relied on for graduating. Such a serious state of things, so far from justifying an award for superiority in graduating, should have induced a strict investigation into the real cause of the failure, and not a mere supposition that it "*may* be due to the reason given by the company's agent."

The fact that all the brakes acted shortly afterward at an emergency stop really has no bearing on the graduating power. The latter was defective either through leakage which permitted the power to escape while the brake was on for some time, or through defective action of the ball or check valve on some of the vehicles. The change of pressure in graduating might be so gradual as to be unable to seat this valve, though the sudden rush of air in a full application would do so. In other words, the brake would not graduate.

Some of "the diagrams which show in a very marked degree the superiority of the vacuum graduation" are certainly unique, for they show the brake to have been on for several miles while the train was *ascending* long grades of 160 ft. per mile.

This absurd result, evidently caused by some error in the vacuum gages, appears to have escaped observation, and does not inspire one with confidence in the conclusions based on these diagrams as regards the graduating power of the brake. Fortunately, other diagrams are given bearing on this point, showing the speed and grades, and giving the train pipe and cylinder pressure of the Westinghsuse, as recorded by the Kapteyn indicator used in several European brake trials. Similar data respecting the Vacuum are given by a less perfect instrument.

The majority report continues: "The constantly varying grades require a variation of retarding power which can only be met by a perfect graduation, both on and off, so that a uniform speed can be approached." An examination of the diagrams as regards variation in speed shows, however, that with trains of 35 "wagons" and two engines the greatest variation of speed was 9.0 miles per hour with the Westinghouse and 14.0 miles per hour with the Vacuum. With trains of 20 "wagons," drawn by one engine, the variation in speed was 8.2 miles per hour with the Westinghouse and 12.9 miles per hour with the Vacuum. Consequently on this score the graduation of the Westinghouse was superior to that of the Vacuum. The diagrams taken with a clockwork recorder of the train pipe vacuum in the rear "van" or caboose show, moreover, that the release of the vacuum was invariably very slow, the average time to increase the train pipe vacuum 5 ins., or about one-fourth the working vacuum, being 50 secs. with the 20 car train and 68 secs. with the 35 car train. With such a slow release an uneven speed is inevitable, as the train on entering a level or rising gradient will be checked unduly before the brake is released. While the power to graduate "on or off," increasing or decreasing the pressure in the brake cylinder at will, is a desirable feature in a brake, it is worse than useless unless combined with rapidity, and it is a pity that the framers of the majority report evidently omitted to study these diagrams before committing themselves to a statement that the diagrams confirm the superiority of the "on and off" graduation, when the very reverse is the case. This leaves the advocates of the Vacuum with but two points on which to recommend that brake, "simplicity of construction and probably economy in maintenance."

Mr. D. H. NEALE, who alone signs the minority report, thus deals with these points: "While the simplicity of the Vacuum brake is obvious and the complexity of the Westinghouse appears objectionable, simplicity may be dearly bought at the expense of certainty of action, and the quicker application and release of the Westinghouse, its greater convenience in shunting and detaching disabled vehicles, with its far greater command of power, its diminished weight and its greater range of motion to take up the wear of brake blocks and tires, far outweigh any supposed advantages due to simplicity. The cost of maintenance is in favor of that brake, which is at once lubricated and protected from dust, while experience proves that with long trains the consumption of fuel would also be greatly in favor of the Westinghouse brake."

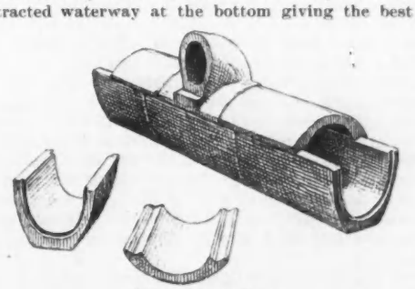
The minority report also enumerates may other points in which the Westinghouse is superior, such as smoother action and absence of shock, 25% saving of time in switching, due to the use of train pipe tests, less liability to leakage, less liability to be injured by dust, freedom from possibility of exhaustion, etc.

The result of the trials was, as stated in these columns, the adoption of the Westinghouse quick-action brake on the New South Wales railways, and 5,000 freight cars are to be fitted as soon as possible, as noted in our issue of Oct. 10.

A New Beton Sewer Pipe.

The sewer pipe illustrated above is made of beton composed of Portland cement with clean, sharp sand, or crushed granite, or hard limestone. These materials are mixed by machinery and solidly tamped into polished iron molds. The result is a smooth, hard, strong pipe.

As shown, the cross-section is an oval, the contracted waterway at the bottom giving the best



Beton Sewer Pipe.

scouring effect with a small flow. The invert has a broad, flat base, making alignment and jointing easy, and in a wet bottom or on unstable ground the ends can be laid on suitable square piles driven to a grade. The arched cover which breaks joint with the invert, is laid after the first has been set, cemented, inspected and accepted.

The rabbets in the end of the invert piece form a dovetail groove when two of them are joined together; and form a lock when the jointing material is set. This groove is filled from the inside, and being directly under the eye and hand of the pipe layer, perfect and smooth work can be performed.

When these sewers are to be used for the removal of ground-water, the joints between the cover pieces can be left uncemented, but covered with a strip of muslin to exclude loose earth. Lateral sewers would enter the mains by properly molded Y's, while house drains and small laterals would enter through branches in the cover pieces, as shown. In the original laying of this sewer all house branches can be omitted and put in as needed.

Concessions will be granted for the manufacture of this pipe, on royalty, to all requiring it; but the materials and methods will be under the control of the owners of the patents, the Waring Sewer Pipe Co., of Newport, R. I.

The Harvey Process of Surface Hardening Steel.

The process of hardening the surface of steel, invented by HAYWARD A. HARVEY, of Orange, N. J., has been brought into great public prominence through the remarkable results which armor plates treated by this process have shown in the Government tests (See ENG. NEWS, Feb. 21, May 16, 1891.) The resistance to penetration, combined with great toughness and resistance to cracking, in the plates tested were quite as phenomenal as the qualities shown by the nickel steel plate which came off victorious in the famous tests of one year ago.

There has been much inquiry as to the process by which these remarkable results were obtained; but, owing to the pendency of certain patents, the Harvey Steel Co. have avoided publication of the details of their process.

At present, however, two United States patents have just been issued to Mr. HARVEY, one for a "Decrementally Hardened Armor Plate," the other for a gun in which the same principles are taken advantage of. The specification of the former patent gives with considerable detail the method employed in this "decremental hardening." We quote from it as follows.

The armor plate having been formed of the desired size and shape from a comparatively low steel, such as Bessemer steel or open hearth steel, containing, say 0.10% to 0.35% of carbon, is laid, preferably flatwise, upon a bed of finely powdered dry clay or sand, deposited upon the bottom of a fire brick cell or compartment erected within the heating chamber of a suitable furnace, The plate may be so embedded that its upper surface is in the same plane with the upper surface of those portions of the bed of clay or sand which adjoin the sides and ends of the plate, or the plate may, if desired, be allowed to project to a greater or less distance above the surface of the clay or sand. In either case the treating-compartment is then partially filled up with granular carbonaceous material, which, having been rammed down upon the plate, is covered with a stratum of sand, upon which there is laid a covering of heavy fire-bricks. The furnace is then raised to an intense heat, which is kept up for such a period of time as may be required for the absorption by the metal adjoining the upper surface of the plate of, say, an additional one per cent. (more or less) of carbon, or, in other words, the quantity of carbon, in addition, to that originally present, which may be necessary to enable the said metal to acquire the capacity of hardening to the desired degree. The temperature of the heating chamber outside of the treating compartment is brought up to a height equal to or above that required to melt cast iron, and is kept up for a greater or less length of time, according to the depth of the stratum of steel which it is intended to charge with an excess of carbon. This period, however will of course vary according to the efficiency of the furnace.

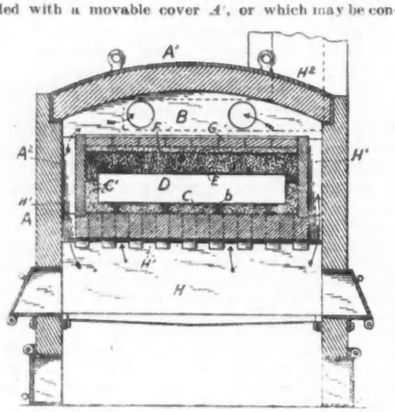
The degrees of efficiency possessed by different furnaces can only be satisfactorily ascertained by actual trial. When ascertained, the reproduction of given results merely requires the re-establishment of the conditions as to time and temperature under which said results have been previously observed to be obtained. This involves merely the maintenance of the furnace at a heat sufficient to melt cast iron for the period which by previous observation has been ascertained to be the period required for adding to the tenacity of the steel and for the supercarburization of the plate to the prescribed extent and depth. For example, a plate, say, 10½ ins. in thickness, composed of a comparatively low steel, containing, say, 0.35% of carbon, may be charged with additional quantities of carbon, gradually varying in amount from, say, 0.10% at a depth of 3 ins. beneath the surface of the exposed side of the plate to 1% at the surface thereof by a continuance of the treatment for a period of, say, 120 hours after the furnace has been raised to the required temperature.

The statement that the heat at which the furnace is maintained is sufficient to melt cast iron is to be regarded as approximate merely. The more intense the heat the better, and while it will of course be understood that the longer the treatment is continued the greater will be the

depth to which the carbon penetrates beneath the surface against which the carbonaceous material is packed, it is also to be remarked that the penetration of the carbon is greatly facilitated by the continuous firm compression of the carbonaceous material against the plate. As a general rule, the thicker the armor plate the greater will be the permissible depth of supercarburization. A 10½ in. plate and a depth of supercarburization of 3 ins. are herein referred to merely for the purpose of illustration.

After the conclusion of the carburizing treatment the plate is taken out of the furnace, and without removal of the carbonaceous material from its surface is allowed to cool down to the proper temperature for chilling. During the cooling operation the carbonaceous material protects the hot supercarburized surface from the air, and thus prevents the formation of scale, which if present, would interfere with the subsequent hardening of the metal beneath it. The carbonaceous material, however, may without injurious consequences be temporarily removed from and quickly replaced upon small portions of the supercarburized surface for the purpose of exposing them for observation. When it is seen that the supercarburized surface is so far cooled down as to have a dull cherry-red color, the carbonaceous material is quickly removed, and the plate is then chilled by being sprayed with torrents of cold fluid or by being submerged and kept in motion until cold in a large body of cooling-fluid—as, for example, a more or less rapidly running stream or river of fresh water or a tidal current of salt water. The exercise of this precaution insures the subsequent uniform hardening of the supercarburized surface of the plate.

The drawing represents a furnace A, which may be provided with a movable cover A', or which may be constructed with reference to having one or both of its end walls removed to facilitate the removal of the plate in a horizontal direction. Within the heating chamber A^2 of the furnace is the treating cell or compartment B, preferably provided at the bottom with a series b of parallel rails, which are imbedded in a stratum of sand C of the same height as the rails and are intended for the support of the armor plate D. The space around the ends and sides of the armor plate is also filled with sand C' nearly or quite to the top of the plate. A stratum of granular carbonaceous material E, rising to a height of, say, 8 ins. above the upper surface of the plate D, is tightly rammed down on to the top of the plate and is surmounted by a stratum of, say, 2 ins. of sand F, covered by a layer G of heavy firebrick. The stratum of sand F and the layer of firebrick G not only protect the carbonaceous material from the fire, but serve to weight the carbonaceous material down upon the plate.



Section of Furnace for Treating Armor-Plates by the Harvey Process.

The treating compartment B is heated by the flames and hot products of combustion from the fire chamber H, which are led upward through the flues H' and directed inward over the tops of the treating compartment and finally discharged into the chimney or smokestack H^2.

With a furnace of the character shown in the drawings a period of about 48 hours will be required to bring up the heat to the required point, and such heat will be required to be kept up about 120 hours. A further period of four or five hours will ordinarily be required after the fire has been drawn to remove the plate from the furnace and have it cool down to the desired dull red color. The spraying operation will be required to be continuously kept up for a period of about four hours in order to effect and preserve the chilling of the supercarburized surface until the remainder of the plate has become completely cool. A plate of 10½ ins. in thickness thus treated will be found to be excessively hardened upon its supercarburized surface and at the same time to be remarkably tenacious, so that a hardened projectile of say, 6 ins. diameter, weighing 100 lbs., fired at it with a striking velocity of 2,000 ft. per second, will be shivered to fragments without deeply penetrating the plate. The extreme point of the projectile, which may slightly penetrate the plate, will be found to be welded thereto by the great heat resulting from the sudden stoppage of the projectile in its flight.

Owing to the great tenacity and the heterogeneous crystalline structure of the supercarburized and hardened stratum, its tough backing, and the entire homogeneity of the plate from one surface to the other, except as to its crystalline structure, there will be no cracking off of the hardened exterior stratum and no complete piercing of the plate by the projectile. In these particulars the plate will be found to differ in a marked degree from all armor-plates heretofore known.

What is claimed as the invention is:

1. The herein described method of producing a decrementally hardened tenacious armor plate, which consists in inclosing a low steel plate between a mass of non-carbonaceous material on one side and a mass of granular carbonaceous material firmly packed upon the other side contained in a compartment formed within the heating-chamber of a suitable furnace, and in maintaining the said heating chamber for a predetermined period of time at a temperature above the melting point of cast iron, and in subsequently chilling said plate, whereby a stratum of steel of prescribed thickness upon the side of the plate against which said carbonaceous material has been pressed is made to acquire a heterogeneous crystalline structure and a condition of excessive hardness upon its exposed surface and a condition of gradually diminishing hardness as the depth from said surface increases.

2. As a product of the herein described process, the decrementally hardened steel armor-plate herein described, consisting of a plate of tenacious steel presenting upon the side intended for receiving the impact of projectiles a stratum of prescribed thickness of ununiform crystalline structure uniformly and highly supercarburized and excessively hard at its exposed surface and less and less carburized and gradually diminishing in hardness as the depth from said surface increases.

In the patent for gun manufacture just issued to Mr. HARVEY, the object is to produce a steel cannon or piece of ordnance with a hard interior and exterior surface, and a soft, tough body. The advantages of this are that the interior surface is so hard that it is incapable of being cut or scratched by the action on it of the projectile when the gun is fired; also that while the body of the gun is tough and resilient, the hardened external surface acts as an inextensible hoop, which completely surrounds the body of softer steel and effectively prevents it from being permanently expanded by the force of the explosion when the gun is fired. The cylindrical stratum of comparatively soft steel acts as a buffer to protect the exterior stratum of hard steel from the immediate shock of the explosion, which but for this might be sufficient to burst the exterior stratum of hardened steel.

These results are attained by filling the gun to the muzzle with finely powdered charcoal, after it has been cast or forged and turned to the desired shape and dimensions, then embedding the gun in an external layer of finely powdered charcoal contained in an air tight receptacle made of fire brick. This receptacle is placed in a furnace chamber, and a temperature sufficient to melt cast iron is maintained until the carburization of the surface layers of the metal is carried sufficiently far.

The duration will of course vary according to the efficiency of the furnace, the character of the fuel and the size of the gun. No general rule can be given, and experiment must determine this; but for illustration it may be said that a continuation of the heat for a period of 30 hours after the furnace has been made hot enough to melt cast iron will be sufficient for guns of 4 ins. calibre. By such treatment a gun composed of steel, originally containing say 0.25% carbon will be supercarburized on its interior and exterior surfaces to such an extent that the surface strata of the metal will each contain 1.0% to 1.1% of carbon. This percentage will gradually lessen until at a point say ¾ in. from the exterior surface, and ½ in. from the interior, the metal will contain only its original percentage of carbon.

Upon hardening the gun, by removing it from the furnace and plunging it into water, when it has cooled to a dull red or other desired heat, the supercarbonized strata will take the tempers corresponding to their relative percentages of carbon. The highly carbonized metal in contact with the charcoal will be so hard it cannot be cut or scratched by an ordinary cold chisel or file. As the exterior supercarbonized layer is the main reliance for strength, it is desired that the carbonization shall extend to a greater depth on the exterior than on the interior. But as the exterior of the gun is more directly exposed to the heat of the furnace, there is no difficulty in securing this result.

Both the above patents refer to a previous patent issued to Mr. HARVEY Jan. 10, 1888, and state that the process therein described is similar to the one contemplated under the present patents. The previous patent is for a process of treatment of mild steel made by the Bessemer or open hearth process, by which its percentage of carbon is so increased that it acquires the characteristic properties of refined crucible steel. Indeed the inventor says in his specification:

It will be found not only that tools made from the gray-colored product produced by the process herein described will do perfectly well all the kinds of work which tools made from Mushet steel are capable of doing, but that they are superior to tools made from any other steel whatever for certain purposes—such, for example, as boring deep holes in chilled iron or steel, or turning or planing the surfaces of thin shelled chilled iron or steel castings.

The process consists simply in imbedding the piece of steel to be treated in finely powdered charcoal, inclosed in a crucible made of plumbago or other refractory material, and keeping the crucible and its contents at a heat above the melting point of cast iron for a period depending on the temperature, the size of the pieces to be treated and the percentage of carbon desired. According to the specification, percentage of carbon may be regulated best by varing the temperature to which the material is heated.

A most interesting point in connection with the Harvey process is the fact that the surface of the metal treated is always left clean and smooth on the conclusion of the process. As is well known, heating bars of wrought iron in contact with charcoal is a process of steel manufacture over two centuries old; but in this, generally known as the cementation process, the bars when removed from their charcoal bed are found to be covered with blisters, whence the name, blister steel. Mr. HARVEY alludes to this in his patent of 1888, and expressly states that while this is true of the cementation process, the product of his process is so free from scale or blisters that knives, files and other instruments made of mild steel may be subjected to the treatment without injury and be thereby transformed into steel of fine quality. None of his specifications, give any clue to the reason why the blisters do not occur in his process, but we believe he considers the probable reason to be the intense heat employed.

Perhaps the use of mild steel instead of wrought iron as the raw material may help to account for the absence of blisters, as the English metallurgist, PERCY, has shown that homogeneous metal, free from the cinder which is contained in wrought iron, does not blister on cementation.

Another point of interest in the inventor's specifications is his claim that the pieces of metal when heated in close contact with powdered charcoal, as above described, will remain solid although exposed to a temperature above their ordinary melting point.

Stone Arches, with Lead Joints at the Key and Point of Rupture.

In the *Annales des Ponts et Chaussées* for June, 1891, there is an interesting and lengthy paper by G. LA RIVIERE, upon recent German practice in building masonry bridges with lead joints at the key and points of rupture near the springing lines. For a long time German engineers have preferred masonry structures to those of iron for bridge purposes, and regard the first as the most economical in cost of maintenance. This preference has led them to deeply study the art of masonry construction, and we append an abstract of results of some of their experiments.

One point especially remarked in this German practice is the low cost at which they have built stone arches with openings of from 65 to 150 ft. This economy is without doubt greatly due to the low cost of hand-labor; but above all to the constant care of the German engineers not to exceed the cost of an equally good metal bridge for the same site. The author says, however, that in striving to attain this end the German engineer frequently lays himself open to criticism in details, and cites an arched bridge of 92 ft. apparent span and 134.5 ft. real span between foundations. In this bridge the light flagstones forming the footwalks are carried upon boldly projecting brackets held in place by iron hooks or bent bars. The parapet is surmounted by a wrought iron railing, more or less ornamental, but not in keeping with the massive masonry below and the great span of the arch. In other arched bridges of

65 ft. span the roadway rests upon arched supports of light material, held together by iron bars which project beyond the face of the arch wall and sustain the footwalks.

But Mr. La RIVIERE admits that in the essential features of arch construction the German engineers have introduced a very satisfactory and economic practice, very reasonable, and of great simplicity. The cost of their work is also extremely low. Figuring upon the actual span of the arch between the foundations, the prices per superficial meter (10.76 sq. ft.) on plan is given as follows:

Bridge.	Arch span.	Cost per sq. m.
Over the Enz.....	45 m. (147.60 ft.).....	172.5 f. = $34.50
" " "	20.6 m. (67.57 ft.).....	112.5 f. = 22.50
" " Glatt....	20.8 m. (68.22 ft.).....	78.75 f. = 15.75
" " Murr	43.5 m. (139.7 ft.).....	131 f. = 26 20

All these bridges are built with the arch curve extending to foundations absolutely horizontal, and the opening is limited by the height of the natural soil above these foundations. The curve of the intrados is usually the basket handle, or *anse de panier*, in which the apparent arch has a very low rise in proportion to the span, generally about 1 to 10. The portion of the arch above the ground is laid in courses, and the arch stones have a thickness of from 16 to 20 ins. at the springing line. The curves limiting the sunken abutments are parallel to the curves of the intrados and extrados prolonged to the foundation.

The abutments themselves are generally made of Portland cement, sometimes having large blocks of stone buried in the mass of beton and disposed on radial lines. The beton is made of 1 part cement, 3 parts sand and 1 part broken stone, and in arches of light span the stone blocks used occupy 30% of the mass. The arches themselves are in cement beton, for spans under 98 ft., made 1 part cement to 3 parts sand and 4 parts of broken stone. When it is desired to give the arch a more finished appearance the beton is used only in the body of the work and the face is made with cut stone voussoirs and the spandrils in rock-face irregular-range masonry. The mortar used in this work is usually made of 1 part cement to 1½ parts sand. In arches of large span cut stone in courses is used for the voussoirs and this is backed by quarried stone. The joints of these voussoirs are from $\frac{1}{10}$ to $\frac{3}{10}$ in. thick, and these are filled with a dry mortar packed in with thin tamping-irons. The haunch arches for carrying the roadway are built of rough stone laid in Portland cement mortar, of 1 cement to 3 parts sand, or in cement beton made with 1 part cement, 2 of sand and 3 parts of gravel. The arches are covered with a mortar made of 1 part cement and 1½ to 2 parts of sand. This layer is only about 1 in. thick, but it is usually covered by a layer of asphalt $\frac{3}{10}$ in. thick. The water collected on this final coat is led to outlets near the springing of the arch, or into dry stone drains behind the abutments.

All the details of these arches are judiciously planned and economical, and the thickness of the masonry in all parts is reduced to the minimum of strict necessity. But the only original point in the German practice worthy of special treatment is the manner of building arches of large span and the method adopted for preventing the appearance of the cracks too common in the ordinary process of flat arch-building. This portion of their practice can be described as follows:

The bridge over the Nagold, built in 1882, is the first great work in masonry executed in Wurtemburg, and it served as a point of departure in the later practice of the German engineers. The "apparent" opening in this arch is 108.24 ft. with a rise of 1 in 10 in this portion. The real span between abutments is 151 ft. The sunken abutments are made of cement beton, and the parts of the arch covered by the ground are laid in rough stone. The center was loaded, before commencing the laying of the "apparent" arch, with the whole of the voussoirs, and the voussoirs nearest to the springing lines were laid dry and the arch was in masonry over its whole thickness, and the keying was done simultaneously at the crown and the springing lines. On striking the centers, 42 days after the keying, a sinking at the crown of 1.68 ins. was observed and some cracks appeared near the spring of the arch.

To prevent these cracks from appearing in the future the German engineers concluded to put into practice a method proposed by Mr. DUPUIT; that was, to form joints at the key and the points of rupture in the arch so as to bring the curve of pressure within the lines of the voussoirs and permit the two parts of the arch lying between the key and the springing lines to move with freedom.

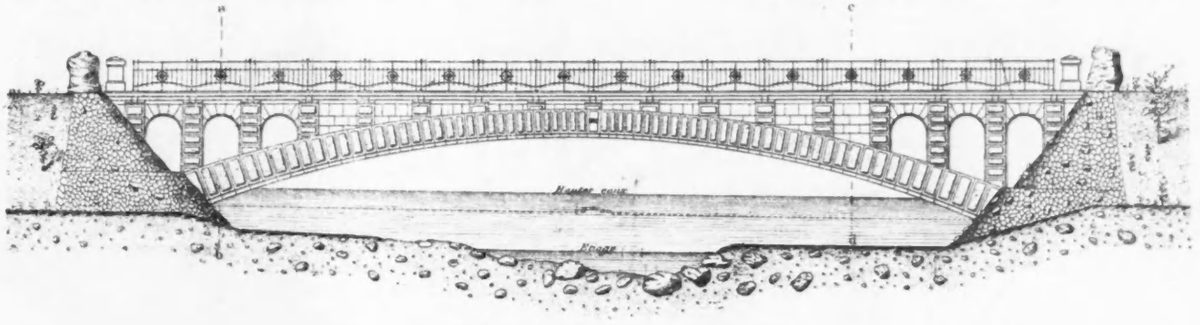
Mr. DUPUIT proposed to open the joint of rupture at the intrados up to the middle of the joint, and to use for the adjoining voussoirs very hard stone, or even to protect the surfaces with metal. Other engineers proposed to round the surface of the upper voussoir, or to leave it flat at the middle and round the two extremities. But the trouble was that this disposition would bring a very great pressure upon the point of contact, and there was the danger of breaking the voussoirs nearest to the joint. So Mr. CROIZETTE-DESNOYERS, while recognizing the value of any device for passing the curve of pressure through the center of these joints, concluded as follows: That joints were used with success in metallic arches, because by the aid of rounded surfaces it was possible to concentrate at the point of rotation a surface equivalent to that of an ordinary joint. But this device fails completely in masonry structures, and he did not think that the curved joint could be used.

But M. LIEBBRAND, of Stuttgart, proposed, instead of cylindrical or polygonal joints in iron, to put sheets of lead, $\frac{5}{10}$-in. thick, between the joints at the key and the points of rupture. These leaden plates were to occupy only the middle third of the height of the joint, the other two-thirds remaining empty. The lead has the property of yielding laterally under pressure without losing its cohesion; and in this way it was possible to form a rudimentary joint which would limit within a small area the zone in which the curve of pressure was free to move under permanent or accidental loads on the arch.

To better appreciate the merits of this device, Mr. LEIBBRAND studied the resistance of lead under pressure; but he first calls attention to the fact that the arch is thus virtually reduced to one-third of its depth at the key and the springing lines. He found that ordinary cast lead, in cubes of 0.08 m. (3⅛ in.) on the sides, and a density of 11.3, would support a pressure of 50 kg. per sq. cm. (711 lbs. per sq. in.) for 26 hours without showing signs of lateral yielding. Under a pressure of 72 kg. (1,023 lbs. per sq. in.) it commenced to yield slowly. By increasing the load every 10 minutes up to 300 kg. per sq. cm. (4,260 lbs. per sq. in.) on the original surface, the horizontal section increased, but not very rapidly. It had an area of 83 sq. cm. instead of 64, and the unit load was 231 kg. in place of 300 kg. In increasing the load from 300 to 900 kg. per sq. cm. (12,780 lbs. per sq. in.) on the original surface, the horizontal section increased so rapidly that the load per sq. cm. of surface only increased from 231 to 294 kg., and this may almost be considered as a constant.

This property in lead is of great importance for the purpose here proposed; for if for any reason the curve of pressure in the arch approaches the edge of the leaden plate, the pressure exceeds the resistance of the metal to compression, and the plate will immediately yield at the point acted upon, and the pressure per unit of surface will be reduced in proportion. Disks of cast lead, 0.16 m. in diameter and 0.015 m. thick, analogous to the joints of 0.02 and 0.022 m. used for the thickness of the leaden joint plates, offered a resistance to compression much greater than was found in the leaden cubes first referred to. They supported a permanent load of 100 kg. per sq. m. (1,420 lbs. per sq. in), and only commenced to yield slowly under a pressure of 150 kg. (2,130 lbs. per sq. in.). Cubes of hard lead of 0.08 m. on the sides, resisted a permanent load of 250 kg. (3,550 lbs. per sq. in.), and only commenced to yield under a pressure of 300 kg. (4,260 lbs. per sq in.).

While the Stuttgart experiments might have been extended, it may be considered as absolutely demonstrated that sheets of soft cast lead, from 15 to 20 m. m. thick, will support without yielding a pressure of 120 kg. per sq. cm. (1,704 lbs per sq. in.), and upon this basis the German engineers have calculated the width to be given to the joint plates. This width ought to be as small as possible, as it is desired to concentrate the movement as at a true joint. Calculation demonstrates that this width is generally considerably less than one-third of the total voussoir joint; but as a precaution it was made one-third in the four German bridges described.



GENERAL ELEVATION OF BRIDGE.

As to the durability of lead used in works intended to be imperishable, we have the experience of the Romans, who sometimes used leaden sheets between cut stones. In the bridge at Chester, over the Dee, built in 1833-34, and the bridge at Turin, over the Dora, built in 1834, bands of lead were placed in the joints for two-thirds of the distance above the springing line. And the bridge of Berne, over the Aar, built in 1844, had leaden plates in the joints of rupture. In all these bridges the lead was used both for maintaining the proper interval of joint and to uniformly distribute the pressures at the time of striking the centers.

It now remains to be seen how Mr. LEIBBRAND treats the difficulty of reducing the thickness of the arch to one-third of its normal thickness at the key and rupture points. The voussoirs nearest to the leaden joints, in this system, undoubtedly are subjected to a very considerable strain over a part of their surface. Mr. LEIBBRAND admits the use of pressures equal to 120 kg. per sq. cm., while ordinary bridges support much less. For example, the Coblenz bridge is subjected to a pressure in the arch of 63 kg. and the bridge at Cologne of 54 kg. per sq. cm.

After having intimated that the voussoirs adjoining the leaden plates ought to present an exceptional resistance to pressure, and be made of basalt, granite or silicious sandstone, Mr. LIEBBRAND adds that this precaution is only necessary in works presenting very exceptional dimensions. It is generally sufficient to use for these voussoirs stone capable of resisting 750 to 800 kg. per sq. cm. (10,650 to

11,360 lbs. per sq. in.), and this was the practice in the four Wurtemburg bridges, and the average coefficient of safety was 1 to 19.

We select from the several plans and descriptions presented in this memoir the bridge over the Enz, near Hofen. The "apparent" opening is 98.8 ft., with a versed sine of 9.2 ft., or $\frac{1}{10}$. The span at the foundation level is 147.6 ft.; the width between parapets is only 12.8 ft., of which 8.2 ft. is roadway. The foundations of the abutments rest upon a striated sandstone cut to a skewback form, and covered with a bed of sand and gravel. Portland cement, made at Planbeuren, was employed for the beton in the foundations and for all the masonry. Out of each car-load of this cement a sample was taken, and gaged with sand in the proportion of 1 to 3; this briquette was put under water for one day and left in the air for 6 days; they set rapidly for foundation use and when tested in tension were expected to resist 113 lbs. per sq. in. Cement with a slow setting was expected to stand 168 per sq. in.

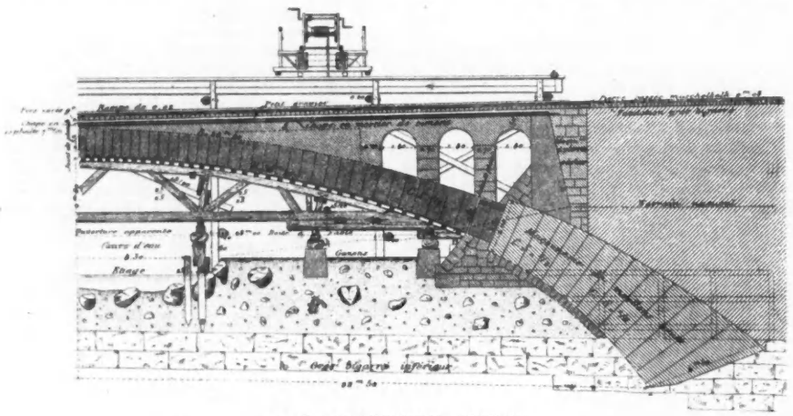
The buried abutments rest upon beton foundations made with rough stone laid normal to the joints of the intrados. In this part the soffit of the arch rested upon a bed of stone covered with a coating of dry mortar and forming a center. The timber center rested upon piles and temporary piers. Sand boxes were used for striking the centers, with a base 10 ins. square, and the depth of the sand was 4¾ ins. The sand was washed and dried and sheets of tin prevented it from being wet by the rains. This center was loaded with all the voussoirs before the archwork was commenced, and the latter work was performed symmetrically and in two days. The movement of the center was insignificant, varying from .039 to .117 in. The whole arch was built of an excellent sandstone, having an average resistance to crushing of 935 kgs. per sq. cm. The soft leaden plates were 1.64 ft. wide and ¾ in. thick, and were placed in the middle third of the joints. These lead plates rested with the lower edge upon three points projecting from a groove in the lower stone filled with lead. The upper voussoir was then carefully placed upon it and the remainder of the joint was filled with tow and a light bed of cement. The lead plates at the key were only 1.15 ft. wide and $\frac{5}{16}$ in. thick. Each joint was made with three pieces of lead.

The masonry arch was laid with ⅝-in. joints secured by blocks of wood 2 in. by ⅝ in. After a row of voussoirs were set the joists were washed and calked with tow to a depth of 1¼ in., and finished with a pointing mortar of 1 cement to 1½ sand, driven in with a calking tool. Near the key the five last joints were made simultaneously. Eight masons and 8 helpers, divided into two gangs, laid the whole arch in 7¼ working days.

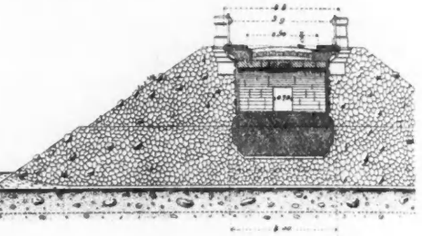
Five days after the keying of the arch the sand-boxes were tapped, but the center was only lowered 0.117 in. After six like tappings, the arch lowered at the key ¾-in. on the up stream side and ⅝-in. on the down stream side. It was lowered again 28 days after the completion of the arch, and the sinking of the crown was then 1⅛ in. up stream and 1 in. down stream. Finally, 35 days after keying, the center was entirely struck, and the sinking at the crown found to be 1⅝ ins., up stream and 1⅛ in. down stream. In the four weeks which followed, and with all the masonry completed, there was observed a total sinking of 2¼ ins. up stream and 2$\frac{1}{16}$ in. down stream. Later observations fail to detect any further settlement.

On examination the leaden plate at the key was found to be in perfect contact with the adjoining voussoirs, over all of its width. Its thickness decreased by 0.7 mm., at the intrados, by 2.4 and 2.7 mm. at the extrados. The pressure is not uniformly distributed, and the line of pressure meets the joint above the middle point, and in a zone equal to $\frac{1}{5}$ of the width of the sheet of lead. The pressure upon the heaviest loaded edge of the lead sheet does not exceed 120 kg. per sq. cm., and the load upon the adjoining voussoirs, under the most unfavorable condition, does not exceed 28 kg. per sq. cm.

The leaden plates at the springing lines behaved differently. The joint on the left bank of the river enlarged at the extrados 0.3 mm. down stream, and 1.3 mm. up stream, and shrank at the intrados 3.1 mm. down stream and 1.5 mm. up stream. On the right bank of the river the joints enlarged at the extrados 0.2 and 0.4 mm., and shrank at the intrados 2.3 and 2.9 mm. The leaden sheets were free at the upper part; to such an extent that only 1.15 ft. of their original width of 1.64 ft. was in contact. Calculation showed that the curve of pressure struck this joint, under the most unfavorable conditions, at 5¼ in. below the middle line of the sheet. The maximum pressure upon the edge of the sheet touched 130 kg. per sq. cm.; but the lead did not yield. The adjoining voussoirs were subjected to a maximum load of 23 kg. per sq. cm. No fissure of any kind was noticed in the masonry. After the completion of the work the tow in the lead joints was cleaned out and replaced by cement mortar. The total time expended in construction was 10 months, and the total cost was 30,595 francs, or $6,079. The cost per superficial metre (10.76 sq. ft) of plan, of length and width of the "apparent" arch only, was thus $55.43. Calculated over the total span between bottom of foundations the cost per square metre was $34.50.

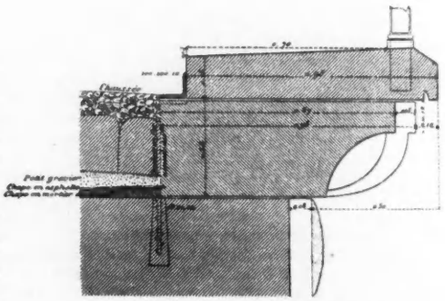


HALF LONGITUDINAL SECTION.



Section a b.

Section c d.



Detail Section of Part of Roadway.

The General Street Law of California.

The cities of California are fortunate in being able to raise money for street improvements under a general law, instead of being obliged, as in some of our Eastern States, to secure authority from the State legislature for every sum raised and expended. The general law was first passed in 1883. In 1885 another one was passed, which has since been amended. The law now provides as follows:

Whenever the public interest or convenience may require, the city council is hereby authorized and empowered to order the whole, or any portion, either in length or width, of the streets, avenues, lanes, alleys, courts, or places of any such city graded or regraded to the official grade, planked or replanked, paved or repaved, macadamized or remacadamized, graveled or regraveled, piled or repiled, capped or recapped, sewered or resewered, and to order sidewalks, manholes, culverts, cesspools, curbing, and crosswalks to be constructed therein, and to order any other work to be done which shall be necessary to complete the whole or any portion of said streets, avenues, sidewalks, lanes, alleys, courts, or places, and it may order any of the said work to be improved.

The law provides that before such orders are made the council shall pass a resolution of intention, describing the same, which resolution shall be published in the city papers and posted about the city. In addition to the above the street superintendent must cause to be posted along the line of the proposed work at intervals of not more than 100 ft., notices of the passage of the resolution. The superintendent must also publish a notice in the city papers.

In case a majority of the property owners, as represented by frontage along the proposed improvement, object to the work they may stop all action for six months by filing their objection with the city clerk, but this does not apply to the construction of sewers, gutters, manholes, the cleaning of the same, or to the construction of culverts, cesspools, sidewalks or crosswalks, or to improvements to complete a short gap at each side of which work has been finished. If any individual property owners feel aggrieved because of the proposed work they may have a hearing before the council by following out a prescribed course, but the council's action on such petitions shall be final.

If the council deem any improvement of more than local benefit, or if the city engineer's estimate shows the cost to be more than one-half the assessed valuation of the property upon which the frontage tax would otherwise be levied, the council may declare an assessment upon the whole district benefited, each piece of property to be assessed in proportion to its benefit from the improvement, which will be determined by the street superintendent. The property owners of a majority of a given frontage may petition for improvements, and the council may, if it sees fit, order work done, after complying with the forms required when the council takes the initiative.

Before ordering improvements the law provides that plans, specifications, and estimates shall be furnished the council, if required by it, by the city engineer, and if sewers are to be constructed specifications must always be furnished by the city engineer.

The law specifies the manner of asking bids and awarding contracts for improvements. All bids must be accompanied by a certified check, to the order of the mayor, for at least 10% of the aggregate amount of the bill, or by a bond, with sureties, for this amount, check or amount of bond to be forfeited in case the successful bidder fails to enter into contract with the city. All moneys so forfeited are paid into the

street repair fund. The cost of advertising for bids and publishing notices in this connection must be paid by the successful bidder before the contract is finally closed, as must the expense of surveys and inspection. These sums the contractor recovers, at least when the cost of improvements is assessed upon property benefited; for in such cases the contractor collects the total cost of the work, including the above named incidental expenses, from the owner of the property. Assessments remaining unpaid, with 10% interest, may be collected by a prescribed process of law.

A curious provision of the law is to the effect that if the owners of three-fourths of the frontage so desire, they may, within 10 days after the notice of the award of the contract has been published in accordance with the law, elect to take the contract themselves at the price named in the award.

The council may reject any and all bids, if for the public good to do so, and must reject all but the lowest bid in any case, except when a bidder is irresponsible or has failed to perform previous contracts. In case a contractor does not complete work within the specified time the council may extend the time or relet the unfinished portion as a new contract.

The total cost of improvements is assessed upon adjacent frontage, proportionately, special provision being made for street intersections and abutments, but the cost of these always being borne by adjacent property and not from the general tax levy or general street fund.

After any street or portion of a street has been improved to the satisfaction of the council, and sewer, gas and water pipes laid in it under such regulations as the council may adopt, then the council must accept the street as completed, and thereafter repairs and improvements must be made by and at the expense of the municipality as a whole. Streets may be conditionally accepted by the council without a sewer or gas pipes or water pipes, if the accepting ordinance states that such improvements are at the time deemed unnecessary. But when such improvements are finally made their cost shall be assessed in the same manner as though there had been no conditional acceptance.

In case the council sees fit the whole or any part of the cost of the improvements named above may be met from the treasury of the municipality from such funds as the council may designate, instead of from a frontage or district assessment of property. If the council think it necessary to pay the cost of sewerage construction from the proceeds of bonds it may call an election to vote bonds, at which a two-thirds vote shall be necessary.

When sewers are paid for from the street contingent fund or from the proceeds of a bond issue plans and specifications for the work, in sections, must be prepared and bids must be advertised for in at least one paper in the city where the work is to be done and one in the city and county of San Francisco, the advertisements to run for 20 days.

Still another way is provided for meeting the cost of street improvements, where the same is more than two dollars per front foot on each side of the street, and the assessment upon any frontage is more than $50. This method is also optional with the city council, and provides for the issuance of serial bonds running not more than 10 years, bearing not more than 10% interest, and payable in equal amounts the first day of January of each year until the term expires. Opportunity is given each assessed property owner to pay the assessment as soon as it is made, and thus prevent the issuance of the bond, the amount of which, with interest, is a first lien upon the property, like ordinary taxes. For assessments not paid within a specified time a bond is issued for each piece of property and delivered to the contractor, who does the work; the bond is payable to the contractor, or order, and the yearly installment of the principle and the semi-annual interest is paid by the city treasurer from the moneys received by him from the owners of the assessed property. If any payment is defaulted the holder of the bond may demand the payment of the whole unpaid balance of the bond, together with interest due, and thereupon the assessed property shall be sold, if necessary, as in the case of delinquent taxes.

When improvements are ordered to streets having any kind of railways upon them, the owners of which are required by law to keep specified portions of the streets in order, then the council may order such owners to make improvements to the specified portions under the same conditions as apply to the remainder of the street. If the owners named do not do the work ordered within a given time, the law provides that the council may have the work performed at the owner's expense.

The law also provides in detail for the changing and working of street grades.

The engineering work in connection with street improvements must be done by the city engineer, or in case there is no city engineer by the county or city and county surveyor. In all cities not having a city engineer the council is authorized to appoint a person to the office and fix his compensation, the law not specifying how the money for the latter shall be provided, whether by fees or salary. The street superintendent looks after all street improvements, prepares the assements, and in general seems to be, according to the law, the general executive officer for the city council in this matter. He has power to appoint superintendents of construction, or inspectors, whose compensation is fixed at four dollars per day.

The sums paid as compensation to the city engineer, the superintendent of construction, and for the cost of printing and advertising in connection with any improvements are termed incidential expenses, and are included in the cost of any improvement. These expenses are paid first by the contractor and then are included in the assessment which he collects from the property owner.

We are indebted to Gladding, McBean & Co., San Francisco, for a copy of the above law, in pamphlet form, which has been prepared by them for gratuitous circulation. The pamphlet contains the amendments made in 1891.

The Manufacture of Continuous Sheets of Malleable Iron and Steel from Fluid Metal.

At the last meeting of the English Iron and Steel Institute Sir HENRY BESSEMER read a paper with the above title, of which the following is a brief abstract.

He commenced his experiments in 1846 with the purpose of making continuous sheets of glass, but the rapidity with which the thin sheet of glass passes from a plastic slate to one of extreme brittleness presented great difficulties. The rapidity with which the sheet was made, a sheet 70 ft. long by 30 ins. wide being produced in 3 to 4 minutes, added to the trouble. But fortunately both iron and steel, after passing from the fluid to the solid state, still retain their malleable qualities and give ample time for further treatment before they become cold.

Sir HENRY announced to the world in 1865 that malleable iron in a molten state could be produced rapidly and in large quantities. He also then conceived the idea of utilizing with this metal his previous experiments with fluid glass and lead, and actually rolled a sheet of iron 3 or 4 ft. long in an ordinary pair of 12 in. chilled rolls used for other purposes. He found the sheet thus produced had a clear surface, almost wholly free from oxidation and absolutely without scale; it was as tough as any rolled iron he had met with. He applied for a patent for his process and obtained it; but as the whole Bessemer scheme was then under a cloud his process excited little attention.

Sir HENRY then proceeds to describe his later development of his first crude experiments, and we give this from the report of his paper in *Industries*, as follows:

These suggested improvements will be readily understood by reference to Figs. 1 and 2; and here I beg to observe that I have not gone into the many details necessary for the construction of rolling mills of this description, but have merely given such an illustration of the general scope of my proposals as will enable them to be understood. The rolls *L* and *M* consist of two hollow drums through which a tubular steel axis *NN* passes, and conveys a plentiful supply of water for keeping the rolls cool. The brasses which support the roll *M* are fixed, while those which support the roll *L* are movable in a suitable slide, and are pressed on by a small hydraulic ram *X*, which is in free and uninterrupted communication with an accumulator, so that at any time, should the feed of metal be in excess, the roll *L* will move back and prevent any undue strain in the machinery, the only result being a slightly increased thickness at that part of the sheet of metal, a defect which, as it extends parallel across the whole width of the sheet, will be easily corrected in the next rolling operation. The rolls, by preference, may be made of 3 ft. or 4 ft. in diameter, each having a flange on one end only, and thus form a trough with closed ends for containing the fluid metal.

In order to obtain a regular and quiet supply of metal, I employ a small iron box or reservoir lined with plumbago or fireclay. Along the bottom of this reservoir, some 10 or 20 small holes of about ¼ in. in diameter are neatly molded by a row of conical brass pegs. The reservoir is provided with a long bar or handle at each end, as shown in longitudinal section in Fig. 2. By means of these bars the reservoir is fsupported on the side frames, the bars falling into suitable notches made in the roll frame for that purpose.

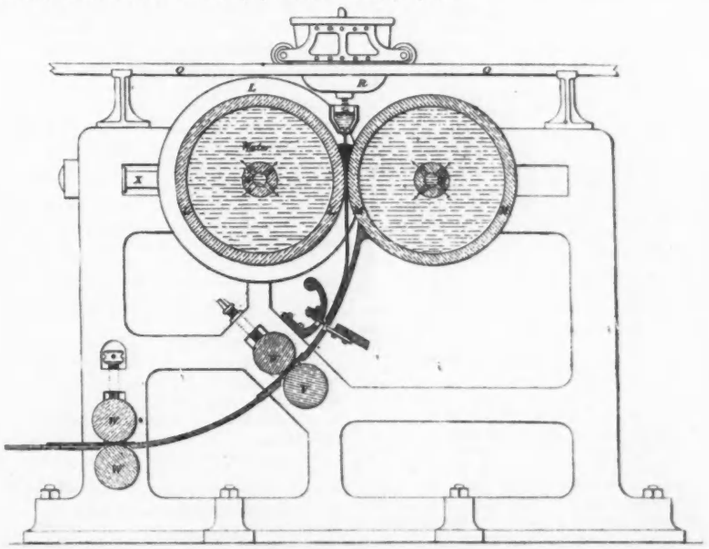


FIG. 1. VERTICAL SECTION OF APPARATUS

And here I would observe that the reservoir should be well dried, and its interior surface heated to redness prior to its use. For this purpose a small furnace or stove should be placed near to the rolls, the stove having two or three rectangular openings on its upper side, in size

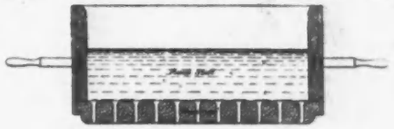


Fig. 2. Section of Reservoir.

corresponding to the interior of the reservoirs, which are to be inverted over these openings, the hot products of combustion passing freely through the row of holes and bringing up the interior surface of the reservoir to a full red heat. In this state the reservoir is to be placed in its

proper position in the roll frame, immediately after the arrival there of the ladleful of fluid metal. A pair of rails *Q* are supported on the roll frames and serve for the conveyance of the ladle *R*, which is mounted on wheels, and brings the metal direct to the rolls or to any number of pairs of rolls that may be placed in line. The ladle is provided with one or more valves or stoppers of the usual kind, by means of which the supply of metal to the reservoir may be easily regulated; the several small streams from the reservoir will deliver an almost constant quantity of metal, varying only slightly as the operator regulates the head of metal in the reservoir—a means of regulating which a little experience would allow him to utilize with great advantage; from the smallness of the head of metal in the reservoir the several streams will fall quietly without splashing. These streams do not fall direct on to the rolls, but into a small pool formed between the thin films solidifying against the cold surface of the rolls, the metal at all times being free from floating slags.

The speed of the rolls also affords a means of regulating the quantity of metal retained between them; and as a pair of 4-ft. rolls would only require to make about four revolutions per minute, a quick running engine could easily be provided with differential speed gearing, so as instantly to alter the speed of the rolls to the very small extent ever required during the rolling process. The thin sheet of metal, as it emerges from the underside of the rolls, is received between the curved guide plates *S* and *T*, to the latter of which a cutting blade *U* is bolted. Beneath the guide plate *S* a similar cutting blade is arranged to suddenly move forward by a cam and cut the thin sheet in two, the piece so cut afterward passing between the second pair of rolls *VV*, from which it again descends by gravity, and passes between the third pair of rolls *WW*, and is delivered on to a horizontal table, or it may be allowed to slide down the inclined end of a cistern of water, moved slowly forward, and thus cool, and stack a ton of plates without any labor or trouble.

The thickness of plates capable of being produced will much depend on the size of the rolls; if drums of 10 ft. or 12 ft. in diameter are employed, it is probable that plates of ¾ in. in thickness could be produced, or perhaps even thicker. The central space between drums of such large diameter would represent a sort of plate ingot mold with nearly parallel sides for some 8 ins. or 10 ins. in depth. When producing sheets of steel, the initial thickness of which does not exceed $\frac{1}{5}$ in. it might, at first sight appear that the finished plate, with only two more rollings, would not get sufficient work done upon it to develop the same degree of toughness and cohesion that would be obtained by the many rollings which the present system necessarily involves; but a little consideration will render apparent the entirely different conditions under which the formation of the plates takes place. Mild cast steel is a crystalline substance, and follows the inevitable law of all crystalline bodies, in so far as the size of the crystals depends on the bulk of the mass and the time allowed for their formation; the longer the time allowed, and the greater the mass, the larger are the crystals obtained: their planes of cleavage are also more clearly defined, and are more easily separated from each other, or, in fact, have a less amount of cohesion.

A cast ingot of 1 ft. square, quietly reposing in a soaking pit or heating furnace, may go on crystallizing for two or three hours and develop a coarse crystalline structure; but in rolling fluid steel in the manner proposed, we have, in place of the 10-in. ingot, a sheet of one-hundredth of that thickness only, and in lieu of the two or three hours allowed in ordinary cases for the development of crystals, we have, when using a 4-ft. pair of rolls, making four revolutions per minute, a transition from absolute fluidity to absolute solidity in just one-half of a second of time, in a mass of only $\frac{1}{10}$ in. in thickness; and if crystals are developed at any period during the half second of time occupied by this transition they must be microscopic indeed, and possess but little, if any, of the properties that are developed in large masses during hours of repose in the soaking pits; hence it appears to me highly probable that the homogenous fluid metal will pass at once into a perfectly homogeneous uncrystalline body, and being subjected to fluid, semi-fluid and solid pressure in rapid succession, will develop the full cohesive force and toughness which the metal is susceptible of.

With reference to speed of production let us assume the mill to be fitted with a pair of 4-ft. diameter rolls, 18 ins. wide and making four revolutions per minute and set to produce a sheet having an initial thickness of $\frac{1}{10}$ in., and rolled by the third pair to $\frac{1}{20}$ in., we should thus have a surface velocity of the first pair of rolls equal to 50 ft. per minute, and making, when finished, 100 plates, 15 ins. × 12 ins., $\frac{1}{20}$ in. thick and weighing 300 lbs., or equal to a production of 1 ton of plates in 7½ minutes.

Railway Gages in India.

The railway system of India has two gages, the Indian standard gage of 5 ft. 6 ins. and the metre gage. In view of the troubles consequent upon break of gage, Sir EDWARD WATKIN has wisely suggested that these troubles may be reduced to a considerable extent by connecting the several metre gage lines to form a complete system. As the termini of these lines are already connected by the broad gage lines, no new construction would be necessary, but a third rail could be laid on the ties of the broad gage lines, forming mixed gage connecting links. The following is an abstract of the case as presented by Sir EDWARD WATKIN:

In Kattiwar there are 334 miles (open) of metre-gage railway, which have cost $6,250,000. In Rajputana and Central India there are 2,008 miles of metre gage railway, costing $55,000,000. In Oudh there are 278 miles of metre gage railway, costing $4,000,000. In Bengal, there are 1,145 miles of metre gage railway, costing $32,500,000.

These four represent so many distinct unconnected groups, which have been built at various times during the last 15 or 18 years. Their length aggregates 3,765 miles and their cost represents a total outlay of about $100,000,000. They are separated by sections of broad gage lines aggregating about 120 miles in length. The remedy is the cheap mixture of gages, the narrow inside the broad.

The lines of the Kattiwar group belong to Native States and are worked under the control of the states interested. To connect this group with the Rajputana group (seven-eighths of which are worked by the Bombay, Baroda & Central India Ry. Co.) only requires the laying of a third rail over the broad gage between Viramjan and Wudwan, a distance of about 39 miles. The Rajputana group can be connected with the Oudh group by laying a third rail over the broad gage Oudh & Rohilkund State Ry., between Lucknow and Cawnpore, a distance of 45 miles, and the laying of a third rail for about 39 miles further over the Oudh & Rohilkund Ry. would enable through connection to be made between all three of the groups of metre gage railway in Kattiwar, Rajputana, Central India and Oudh with the Bengal group (the greater part of which is worked by the Bengal & Northwestern Ry.) via Byram Ghat, on the Gogra River.

At present all through traffic between the various districts served by these distinct groups of metre gage railway has to be repeatedly transhipped where the breaks of gage occur. These breaks can be avoided, and the whole can be linked up into a continuously efficient system by the addition (at a cost of about $1,000,000) of about 120 miles of metre gage rail inside the existing tracks and on the ties of the broad gage systems. Such a measure would increase enormously the effective value, both to the Government and to all others interested, of the 3,765 miles of now disconnected metre gage railway already built and in operation.

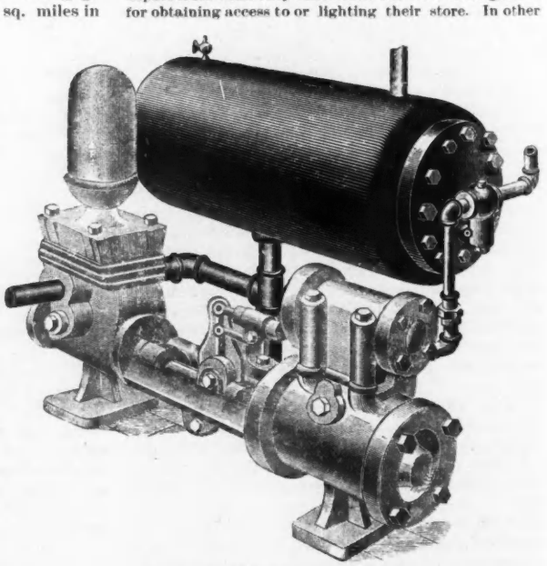
The extent of country served by the metre gage railways referred to represents 400,000 sq. miles in Northern India, in which no broad gage railway exists.

The suggested plan presents decided advantages for strategic as well as economic reasons, and it has already been brought before the Secretary of State for India for consideration.

An Automatic Steam Pump Return for Steam Heating Systems.

Every steam engineer nowadays understands that to secure the greatest economy in the operation of a steam heating or drying plant, the condensed water, which collects at the lowest point of the system, must be returned to the boiler. By so doing, all the heat which is contained in the condensed water is saved; and this is a very considerable amount, especially in plants where high pressure steam is used in the heating coils.

There are various devices in use for effecting the return of condensed water to the boiler. The "steam loop," described in our issue of Aug. 2, 1890, the various styles of steam trap, and the steam pump, are the systems which compete for preference. One point which works against the steam pump in most systems is the fact that it requires so much more attention than the steam loop or steam trap. To meet this objection the Curtis Regulator Co., of Boston, has devised the combined receiver and boiler feed pump illustrated in the accompanying engraving. This is intended to be placed at a point where all the condensed water from a system of piping will drain to it by gravity. The steam valve of the pump is balanced, and is controlled by a float in the inclosed tank. Thus the condensed water which collects in the tank is maintained at a constant level, the float speeding or retarding the pump, according to the amount of water reaching the tank. As the tank is always partly full of steam, the water is kept hot and is pumped hot to the boiler. The suction pipe of the pump extends upward into the tank a short distance, so that scale, &c., from the pipes is not drawn into the pump and forced into the boiler, but collects in the bottom of the tank, from which it can be readily cleaned, the cover being removable.



THE CURTIS TANK GOVERNOR.

Sparks from Locomotives of English Railways.

While sparks from locomotives are a not uncommon cause of fire in this country, especially at bridges and trestles, it is not often that such an accident occurs in England, and the following article from *Engineering*, London, is of interest in this connection:

An interesting case has been tried in the Court of Session, the supreme judicatory of Scotland, practically involving the question as to what means of arresting sparks from a locomotive boiler is efficient. On June 5 last year a flax store in Port Glasgow, 29 ft. from the rails of the Caledonian Ry. Co.'s line from Glasgow to Greenock and the coast, was burned down and the contents destroyed. The contention was that the mischief had been done by a spark from a locomotive, and the company was sued for $60,000 damages. This contention was denied; but the judge has come to the conclusion that it was proved. Contributory negligence was pleaded. The building was of two stories, and, as is the custom with flax stores, there were no windows, the sun having a tendency to deteriorate and diminish the market value of flax. When flax was being taken out or into the store light was obtained through doors, of which there were two on the side next the railway, and through these the sparks flew on the morning in question. The judge considered that this situation of the pursuers' store and this arrangement of the building were certainly not such as to minimize the risks arising from sparks thrown by passing engines. But, on the other hand, he did not know that the pursuers were bound, because of the risk of the negligent discharge of sparks from the defenders' engines, to forego the full use of their ground and to depart from what they considered the best arrangement for obtaining access to or lighting their store. In other words, they took the chance of the railway company doing its duty. Of course if the Caledonian Ry. Co. did not use every precaution in preventing the emission of sparks, then it was responsible by law. This point

of law was not in dispute; but they had to prove that precautionary measures had been taken, and Lord KYLLACHY was of opinion that they had hardly discharged themselves of that onus by leading evidence to the effect "that the engine in question was of the newest and best construction, and that its arrangements for complete combustion were so perfect that if sparks came from it which reached the ground aglow 'either the engine-driver was very much at fault or the coals were bad.'" This was the view of Mr. DRUMMOND, the railway company's late locomotive superintendent, and, as the judge said, "a gentleman of the highest skill and a most excellent and candid witness." It was also the view of Mr. ADAMS, the patentee of the vortex blast, which is the leading feature of this class of engine. Besides, the railway company was responsible for the fault of the engine-driver. Apart, however, from any *argumentum ad hominem*, the judge said he was not satisfied on the evidence that engine No. 85 and the other engines of its class were so constructed as to contain the best known and practical arrangements for preventing the emission of sparks. Differing in this respect from the older class of engines, they contained no "spark arrester" in their smokebox, and, assuming in their favor (what, however, is a matter of dispute) that their vortex blast arrangement did not tend to increase the risk of sparks, or even that its associated arrangements tended to dimish that risk, still, said the judge, the sparks *ex hypothesi* issued and issued of such size as to be dangerous; and that being so he was satisfied upon the evidence that the spark arrester, if used, would at least have reduced that risk. Neither had he been convinced that its introduction would have materially interfered with the working of the engine or been in any other respect injurious. It was true, he remarked further, that a majority of the great railway companies in England had ceased to use "spark arresters;" but they were still largely used, and having given his best attention to the views of the defenders' witnesses, he had been unable to see sufficient reason why they should not continue to be used, or why, if used, they should not go at least a considerable way to obviate the risk of fire. Judgment was therefore given for the Port Glasgow & Newark Sailcloth Co., and it was remitted to a Glasgow accountant to settle the amount of the damage done. The damage was covered by insurance, but this was considered immaterial, as the Sailcloth Co. was perhaps suing on behalf of the insurance company.

Traveling, Postage Rates, Etc., Seventy Years Ago.

A musty little book called the United States Directory, published in 1822, by JOSHUA SHAW, has found its way into our office. It is intended for the use of travelers and merchants, and some of the conveniences offered to the traveling public are interesting at this date. In speaking of New York for example, MR. SHAW says that town is 98 miles distant from Philadelphia, with constant communication kept up between them by stage and steamboat, "and such is the rapidity with which travelers are thus conveyed, that a person leaving New York at 6 o'clock in the morning, will arrive in Philadelphia sometimes by 5 in the afternoon of the same day." MR. SHAW modestly disclaims any certainty of arrival at the hour named, but shows that it is possible "sometimes" to make the 98 miles in 11 hours. When the weather was bad and the roads deep in mud, 20 years earlier than MR. SHAW's publication, 3 days journey was called fairly good time between the cities named.

The mail coach to Boston, via New Haven and Hartford, started from No. 1 Cortlandt street every morning at 8 o'clock and made the trip of 210 miles through in 38 hours. The fare to New Haven was $5; what it was to Boston is not stated. There was a steamboat line on the Sound to New London, leaving on Monday, Wednesday and Friday; and there was a North River steamboat line for Albany leaving on the same days. The Citizens' Coach and Steamboat Line, for Philadelphia, before referred to, left No. 1 Cortlandt St. at 5 A. M. every morning. The Columbian Line was another route to Philadelphia, by way of South Amboy and Bordentown. The steamboat *Olive Branch* conveyed passengers to Amboy, and made two trips per day. The fare, "through in one day," by the 5 o'clock boat was $5; for the boat leaving at 12 noon, the fare was only $3.50.

The postage rates charged, "conformably to act of Congress," are thus given by Mr. SHAW:

	Cts.
Single letters for any distance not exceeding 30 miles	6
Single letters over 30 miles and under 80 miles	10
" " " 80 " " 150 "	12½
" " " 150 " " 400 "	18½
" " " 400 "	25

Double letters, or those composed of two pieces of paper, were charged double these prices, and triple letters, triple the above rates. Packages weighing 1 oz. avoirdupois, were charged at quadruple rates and in that proportion for greater weight. Newspapers cost 1 cent each for any distance under 100 miles, or to any place in the state where printed. Over 100 miles the rate was 1½ cents. But magazines and pamphlets were rated by the sheet at 1 cent for all distances under 50 miles, 1½ cents between 50 and 100 miles, and 2 cents per sheet for all distances over 100 miles. Special directions are given regarding letters which go "by the British Packets," and "as there are places of the same name in the United States similar to those in Europe," the sender is cautioned to plainly inscribe his letter "per packet." There was only one mail daily to the East, and mails as far South as Savannah, Ga., were made up each day; but for Kentucky, Ohio, Indiana, Missouri and Illinois, and New Orleans, a mail on Monday, Wednesday and Saturday was deemed sufficient. The land mail, between Albany and New York, set out three times a week. Changes in mail routes and time of departure were either few in those days, or the hours were not relied upon, for Mr. SHAW, in his directory for 1822, does not hesitate to publish the mail schedule from Philadelphia as "corrected to Feb. 1, 1820."

The author credits Philadelphia with a population of 143,000, and New York with "upwards of 123,000." Boston had 43,000 inhabitants and Baltimore 62,627. Washington, D. C., had a population of 13,322, as: "while the plan of the city is very extensive, only a small portion of it is yet occupied by buildings." In his description of New York Mr. SHAW thus quaintly refers to the first of our steam battle-ships, and practically the first in the world: "Opposite to New York is the navy yard, where may be seen the celebrated steam frigate built by Mr. FULTON. This stupendous monument of his genius is the most destructive instrument of war that has yet been invented. In a calm it must act with irresistible force, as it can perpetually change its position, either for defence or attack, by the power of its engines, at the will of its commander."

How a vestibule-train, a trip on the *Teutonic* or a ride on an electric tramway would have surprised Mr. SHAW and his fellow "travelers and merchants."

Notes of a Vacation Trip from New York to Salt Lake City and Return.

(*Concluded from page* 358.)

Denver is a live city. It bristles in every part with activity. The business district covers a wide area, and the streets throughout it present a crowded and animated appearance. Numerous large buildings of imposing and beautiful architectural design are in process of erection, while in the residence districts handsome buildings are multiplying with astonishing rapidity. There are so few wooden buildings in Denver that they are really rarities; stone and brick are almost as cheap as wood, and are used, one may say, exclusively. In the business districts the blocks are closely built up; in the residence districts the buildings are isolated, the lots are large, and the beauty and importance of the many very handsome residences are greatly detracted from by the broad spaces unoccupied save by weeds, with the accompanying neglected sidewalks and streets. Even the liberal provision for rapid transit by electric and cable roads which distinguish this go-ahead city are insufficient to keep up with the expansive ideas of the ubiquitous real estate dealer and his attractive suburban schemes. My preconceived idea of Denver was that it was a beautiful city, and that a special feature was its streets, down each of which was supposed to run a clear stream of water from the adjacent mountains. The fact, however, is that until recently the streets of Denver were simply ordinary dirt roads, entirely unpaved, and in the rainy season impassable on account of the deep red mud. Throughout the residence district and over most of the business portion, this state of affairs still exists. The dust nuisance in Denver must be something awful to contemplate. But this enterprising and wealthy city has at last waked up to the necessities of the times, and the principal streets are now very much in the state of eruption that New York is at present. The Barber Asphalt Paving Co. is in possession of several important thoroughfares, and it is probable that before many years go by, Denver will enjoy the luxury of well paved roadways; and with the filling up of the desert places now separating her handsome homes, and the improvement of the consequent lawns, the city of the plains will be, indeed, a "thing of beauty."

Electric and cable roads carry passengers on all the important streets and for miles into the suburbs. Unlimited water for irrigating is furnished by two water companies who are active competitors for business. There are many handsome churches and public buildings; two new large hotel buildings will furnish accommodations for the most fastidious of travelers, and manufactures are gaining a good foothold. Everything in and about Denver is indicative of prosperity, and it has a promise of a future not surpassed by any city west of the Missouri, excepting, possibly, San Francisco and Portland.

The engineering profession is fairly well represented in Denver. I called at the offices of several civil engineers who have been subscribers for many years to ENGINEERING NEWS, but in every case learned that they were out of the city on professional service which would detain them for weeks to come. In the office of Messrs. Martin, Aulds & Follett I was so fortunate as to find Mr. Aulds, who has charge of the city business of the firm, and through his kind courtesy I was enabled to see a great deal of the city in the shortest available time, and also to gain much valuable information concerning its present and possible future industrial condition. Mr. Auld's firm is engaged in the surveys and preparation of plans for several large irrigating enterprises; Mr. Follett is now with State Engineer Nettleton out in the mountains investigating some reservoir schemes.

One day is ample for the "sights" of Denver, and hence by 10:30 A. M. on the 20th I was at the "Antlers" in Colorado Springs, the famous health resort at the very base of the Rockies. Mr. B. H. Bryant, Chief Engineer of the Colorado Midland Ry., and an old and esteemed acquaintance, with his headquarters in this pleasant city, took a half day off for my benefit, and together we drove to the famous "Garden of the Gods," seven miles distant. Like the Mammoth Cave of Kentucky, one has to exercise the imagination a good deal to see all the beauties and "curiosities." It is an excellent card for the vicinity, however, and is a striking illustration of what artists, photographers and advertising can do for a place. Then we drove to Cheyenne Cañon, and climbed to the grave of the famous "H. H."—Helen Hunt Jackson—about a thousand feet above the roadway leading into the cañon. All visitors are expected to cast a stone on the grave, and only by going some distance into the forest were we able to secure the necessary offerings to add to the already large pile that marks the lonely resting place of the gifted authoress.

What the artists have done for the "Garden of the Gods" "H. H." has done for Cheyenne Cañon. Thousands of nearly-dead-for-want-of-breath pilgrims, male and female, who never heard of "H. H." or read a line of her writings, will scour the woods for stones to add to the ever growing pile for untold years to come, and the toll-gate at the entrance to the cañon will, at 25 cents per head, collect a handsome and growing yearly income. If "H. H." had been anxious for notoriety—which we do not assert of her—she could not have hit upon a more clever and effective scheme for immortalizing herself and advertising her books than she unwittingly did. There are now a carriage road, a burro trail and a foot-path to the spot, and as we started in the descent with the night closing in we met a panting couple who breathlessly inquired "how much farther is it to the grave?"

An electric railway runs from Colorado Springs into Cheyenne Cañon. A large proportion of the business of the road is the conveyance of pleasure seekers to the Casino, about one mile east of the entrance to the cañon. This pleasure resort consists of an immense building, recently erected by the Count de Pourtales, a Swiss nobleman and extensive ranch owner in the vicinity. The ulterior object of the Casino is to boom the surrounding real estate, which is laid out into acre lots and the subdivision called "Broadmoor." It is a beautiful site for a town, and if the funds of the enterprising nobleman are as enduring as his enterprise and enthusiasm, his speculation will be a success. The Casino is a handsome concert hall and restaurant, set in well kept grounds; there are not more than two or three better appointed places of amusement in New York City, and the table d'hote dinner is served in true metropolitan style. The visitors to this far-away concert room and restaurant, in the very shadow of the Rocky Mountains, have nothing to learn from any similar institution in America. The original and only "Hungarian Band" discourses a fine musical programme during the evening; this item alone costs the Count $1,800 per month. Water is brought from the adjacent mountains to a large storage reservoir on the Casino grounds. The building is under the management of a superintendent, but the Count also gives it almost daily attention, and insists on every detail being carried out on the truly magnificent scale which he has projected.

Colorado Springs is principally noted as a resort for invalids suffering from pulmonary troubles. It is a small city of wooden houses, the streets are very wide, and the natural gravel surface keeps them always in excellent condition. Water for irrigating lawns and for domestic use is brought from the mountains in open canals; there are several handsome public buildings, the general offices and workshops of the Colorado Midland R. R. are located here, and it is a starting point for excursions to Pike's Peak and to points of interest in the mountains. The "Springs" are at Manitou, seven miles distant, and

reached by electric and steam railways every hour. At Manitou, which may properly be stated as lying at the very base of Pike's Peak, there are several bathing establishments and other institutions for invalids, besides numerous hotels for tourists. I arrived there on the morning of the 21st, to make the ascent of Pike's Peak by the rack railway, opened a few months ago, and described and illustrated in ENGINEERING NEWS, Vol. 24, page 290. The train, consisting of one car and a locomotive, with about 20 passengers, started at 8:30 A. M. The route follows a stream which comes tumbling down the cañon in cascades and rapids from the mountains; the grade is a steep one from the start; on the few level places and in descending the car keeps up a constant and somewhat unpleasant "tetering;" on the ascending grades the motion is very steady. There is not much to be seen except the sides of the cañon until the ascent of Pike's Peak proper is commenced, then the mountain peaks begin to show and as the higher altitudes are reached the grandeur of the view is beyond description. What seemed to be mountains as viewed from the lower levels, now shrink into low ranges of hills, while through the clear atmosphere innumerable peaks, many of them snow-clad, and all clothed in colors varying with the distance, come into sight. Concerning the possible effect of the high altitude on one's breathing, at the last watering station, about 1,800 ft. from the summit, I interviewed the train conductor. He said that ordinarily healthy persons were not affected in the least; he estimated that about one person in 200 suffered; he had been obliged to send the engine down with one lady who apparently was nearly dying, but who covered in the lower altitude; the indications of distress first showed themselves by redness and itching of the nose, then blackness under the eyes, in such cases the parties had better not proceed higher; they would show it by the time they reached this tank if at all. The last 1,800 ft. was steep climbing; the sides of the mountain were covered with broken boulders and looked as if a huge "cultivator" of the style that farmers drag over their newly-plowed fields, had been used to rake down the mountain side. At the top I imagined I felt lightheaded, but after a light lunch in the station house, such feelings departed and only one of exhilaration remained, with no more difficulty of breathing than at sea level. From the summit, 14,400 ft. above sea level the white streets of Colorado Springs were visible between the dark strips of houses, which were undistinguishable as to form or size. The broad plains of Colorado stretched eastward as far as vision could penetrate; elsewhere all was perks on peaks of mountain masses, as bare of vegetation as a block of granite. The air was delightfully cool—an overcoat was not necessary for comfort—and it was warmer than at a half mile lower down. Not a living thing except human beings was visible. About half a mile from the summit is a shanty where live the sectionmen and their families. Men were at work on the track; earth for packing ties was scarce, but was obtainable among the rocks. We lost about an hour on the round trip on account of the engine failing to make sufficient steam at the start, and, leaving our car on the track, the engine was run back to the engine house at Manitou for some slight repairs. After that we were pushed steadily to the summit, although at times it seemed as if the engine would have to "give it up." The road is a grand engineering feat and engineers and contractors may well be proud of their part in it, while we hope the promoters and stockholders will be well repaid for their enterprise and faith. The fare for the round trip in the forenoon is $5.00; in the afternoon $3.00; time allowed on the summit, half an hour, or "lay over" to afternoon train on next day. The second train is more patronized than the first, but the chances for clear atmosphere are in favor of the forenoon ascent. Stages also leave Manitou daily for the summit, fare $3.00, or you can go by burro. It requires considerable enthusiasm to forego the extra comfort and saving of time by the railway in favor of the other means of ascent.

At 8:20 Monday night I left Colorado Springs by the Atchison, Topeka & Santa Fe route, via Pueblo, for Kansas City and Chicago, arriving at the latter city on Wednesday, at 9 A. M. Chicago and the Exposition Buildings are subjects too large for these already too lengthy, gossipy notes. The city is "booming;" huge monstrosities of buildings are reaching skyward in every quarter of the business district; the din and clang of the cable car trains are even more nerve destroying than the thunder of the New York elevated roads, while they render pedestrianism at the street crossings a source of constant danger; the sidewalks are thronged; the great dry goods shops are thronged; the same old fringe of horses and buggies are tied to the sidewalk; the drawbridges were whirling for the passage of great propellers and tugs which belched out dense clouds of the blackest smoke, while the atmosphere had grown denser and darker and nastier than ever. Everybody looked prosperous—just as if each individual had made enough over night on his suburban lot to make life easy for years to come. The average thoroughbred Chicagoan's desire for knowledge is satisfied after he has propounded the following queries: How do New Yorkers feel about losing the World's Fair? Have you counted the stories in the new Masonic building? Do you not want to invest in Chicago real estate; I know of some choice bits near Jackson Park on which you can double your money in a week? Great and wonderful is Chicago; no human mind can accurately predict its future.

Leaving Chicago by the "Limited Vestibule" on the Pennsylvania Railroad at 5 P. M. Friday, I arrived in New York Saturday at 8 P. M., an hour behind time. This was the only instance of "behind time" on the whole trip, and I may add that the dining car service was the poorest fare, the poorest attendance and the highest price of any that I had seen whether in dining cars or at station eating houses. That particular Pullman dining car needs investigation.

The cost of a first class ticket to Salt Lake City is $71.75 and the same for return. The sleeping car charges are $15.50. At Cook's Tourist Agency, however, I bought a round trip ticket over the route indicated for $102.50 with $6.00 additional for "extra fare" on the "Limited Vestibule" trains between New York and Chicago. These tourist tickets I can now confidently recommend. I used them in Europe as a necessity, in this country they are an immense convenience and are the cheapest tickets issued and at the same time fully as reliable, as if issued by any of the great railway companies.

This is a great country which no man can appreciate unless he travels over it and learns its vastly diversified configuration; sees its industries and people and learns how small an atom the individual is in the immensity of the continent and its development. But go where one will the work of the engineer and contractor confronts him; *they* are the modern genii. G. H. F.

PERSONALS.

Mr. W. S. PARKER has been appointed Consulting Engineer for water-works improvements at Jackson, Mich.

Mr. CHARLES E. BUSSELL, C. E., has removed from Eau Claire, Wis., to Room 7, Phœnix Block, Duluth, Minn.

Mr. GEORGE L. SANDS has been appointed General Superintendent of the San Antonio & Aransas Pass Ry., vice Mr. D. B ROBINSON, resigned.

Mr. J. B. JOHNSON has been appointed General Superintendent of the Brinkley, Helena & Indian Bay R. R., vice Mr. GEORGE RICH, resigned.

Mr. W. S. BECKER has been appointed Assistant Superintendent of the Dakota Division of the Northern Pacific R. R., with headquarters at Jamestown, N. D.

Mr. GEORGE E. B. JACKSON, at one time President of the Maine Central R. R. and of the Eastern R. R., died Oct. 19, at Portland, Me. He had of late years been practising law.

Mr. J. E. GREINER, who has been connected with the Baltimore & Ohio R.R. for the last 6 years, has accepted a position as head of the estimating department of the Philadelphia Bridge Works, with office at Pottstown, Pa.

Mr. CHARLES FRANCIS, son of Mr. JAS. B. FRANCIS, of Lowell, Mass., and for some years connected with the government works at Rock Island, Ill., has opened an office for the practice of general engineering, at Davenport, Iowa. Mr. FRANCIS held an important position on the Mexican Central Ry. during its construction.

Mr. A. J. SOVEREIGN has been appointed Assistant Superintendent of the East Minnesota and Wisconsin Divisions of the Northern Pacific R. R., vice Mr. G. W. VANDERSLICE, promoted to be Superintendent of the Manitoba Division. Mr. SOVEREIGN was formerly Assistant Superintendent of the Fergus Falls & Black Hills Division.

Mr. ARCHIBALD ANGUS MCLEOD, President and General Manager of the Philadelphia & Reading R.R. Co., is only 44 years of age, says a Philadelphia exchange. He commenced his railway career as a rodman on the construction of the Northern Pacific R.R., and was engaged on other roads in the Northwest until he was appointed General Manager of the Reading R.R. by Mr. AUSTIN CORBIN. In June, 1890, he was elected President of the same company.

Mr. JOHN MCGEE, C. E., of Buenos Ayres, S. A., arrived by the *Saale* on the 15th after an absence of eight years. Mr. MCGEE has spent a large portion of his professional life in South America and is probably the best informed man in the United States concerning the prospects for engineers in South America, and especially in the Argentine Republic. Mr. MCGEE considers Bolivia the richest mining country in the world; at present there is very little doing there, as the mining region is difficult of access, and the points of egress for the products of the country are on the Pacific side. Mr. MCGEE will return to South America at the end of December to engage in mining in the Argentine Republic. His address while in the United States is care of R. L. Niles, 38 Broad St., New York. To civil engineers anxious to go to South America, Mr. MCGEE has but one word of advice: "Don't."

Col. SAMUEL H. LOCKETT, late chief engineer of the Bogota water-works, Columbia, S. A., died in that city on Oct 12. Col. LOCKETT was born in Alabama, graduated from West Point in the Corps of Engineers previous to the Civil War, and in 1861 resigned his commission and entered the service of the Confederacy. As engineer of the Department of the Gulf, C. S. A., he fortified Pensacola and other points on the Gulf Coast, and during the Vicksburg campaign he had charge of the erection of works during the entire siege of that city. At the close of the war he entered the service of the Khedive of Egypt as Colonel of Engineers; was in the Abyssinian campaign and was with Chinese GORDON in the Soudan and on the upper waters of the Nile. On his return to the United States he was extensively engaged as a consulting engineer in the construction of water-works, and for some years past he has been professionally employed in South America. He was instrumental in obtaining an important concession for the building of railways in Chili, and for some time was engaged in surveys for the improvement of the navigation of the Magdalena River in the United States of Colombia. He was also engineer in charge of the erection of the Statue of Liberty in New York Harbor under Gen. STONE. Col. LOCKETT was a highly cultivated man, an excellent engineer, and had won by his personal qualities a host of friends who will be pained to hear of his death.

NEW PUBLICATIONS.

—*The Transition Curve Field-Book.* Containing Full Instructions for Adjusting and Locating a Curve Nearly Identical with the Cubic Parabola in Transition between any Circular Railroad Curve and Tangent. Simplified in Application by the Aid of a General Table and Illustrated by Rules and Examples. Also Tables of Radii, Sines, Tangents Versines and External Secants. By CONWAY R. HOWARD, C. E. New York: 12mo. pp. 107, $1.50.

The methods indicated in this little work for locating transition curves are really simple, decidedly simpler than some others which have been put out, and the results good. Therefore it will prove a useful book to many engineers. We could have wished that clearness of form had been a little more consulted, especially in the "general table" which is the pith of the whole work as respects the practical field work, and which might easily have been made self-explanatory by adding a little cut on the same or the following page to indicate at once to the eye just what the several lines N, X, Y, P, D, Q, &c. really meant. As it is, the table is so much Greek to the man who has sudden occasion to use it after short disuse, and the translation of it into plain English must be sought on general pages both preceding and following the table.

We may add further that the general method of deducing and using the curve is not that which strikes us to be on the whole the best and simplest, but we are little disposed to quibble over such really minor matters. The locomotive is not particular about mathematical niceties, nor is the average track gang particularly respectful of them. Therefore, any curve of the general nature of the cubic parabola, which can be readily located, is a good one for the purpose, and it is not a very material matter whether it is or is not the easiest to locate of all possible curves for the end in view, so long as it is absolutely suitable and easily located. Mr. HOWARD correctly states that the use of his method presents little if any more difficulty than ordinary circular curve location, and what more need one ask?

—*Librito del Campo.*—Con Tablas Utiles adaptadas al Sistema Métrico; para los Estudios y Construction de Lineas Ferreas. Por JUAN MACGEE, Ingo. Civil, Buenos Aires. Galli Hnos. London, F. & E. N. Spon. 2 vols. 16 mo., flex. leather. Section I, Field formulas and tables pp. 314, $4. Section II. Office formulas and tables, pp. 226 $2.50.

The importance which railway construction is assuming in Spanish-speaking countries is well evidenced by these two volumes, which in some respects are in advance even of the existing field-works in English, and which, in the aggregate, contain about as much matter as the largest of our field-works, while typographically they are highly creditable. It is but natural that a considerable portion of the contents should be a mere reproduction and translation of matter already in print in existing field works in English. The author, necessarily, cannot invent anew methods, tables, and formulas to substitute for those which have been gradually developed by half a century of practice on this and other continents as most suitable for efficient railway work. But in selecting the wheat and rejecting the chaff from the great mass of printed matter which exists on this subject, keeping in view the requirements of Spanish-speaking countries using a different system of measurements, the author has had ample room for the display of judgment and knowledge of his subject, and he has produced a work which is in every way creditable to him, and which should prove a boon to Spanish-speaking engineers in both the new and old world.

The labor devoted to the preparation of this work must have been very great, since a large portion of the tables were recalculated for metric measures expressly for the

work. We are not surprised to learn that all the author's spare time for several years has been devoted to it. The ordinary logarithmic tables are not included in the field section, the idea being that for field calculations the natural angular functions can be used. For office calculations the logarithms of numbers and angular functions are included in the second section. But with this exception nearly all the tables to be found in the largest field-books are to be found in this, and all these tables have been reset in clear and good type, if not also recalculated, while some of the tables are not to be found in the most used American field-books. For instance, SEARLES' transition curve formulas and tables are reproduced complete within it. Of course it is quite impossible for us to attempt to thoroughly check the proofreading of the tables, on which so much depends, but it appears to have been very carefully done.

The second section contains a judicious selection of tables for earthwork calculation, circles, metric convertion tables, &c., &c., in addition to the logarithmic tables already noted. There are no less than 65 metric conversion tables (for metres into feet and the like), each running from 1 up to 109 units and hence making them equally convenient either for exact or approximate conversions. We do not know of so complete a set of these tables in any other publication, and they are, therefore, worthy of special note. A separate edition of them in a small pamphlet would doubtless be widely appreciated.

Were these volumes merely a new accession to a dozen previous competitors for public favor in the same line, as is the case with any new field-book in English, we should feel bound to enter more in detail into its comparative merits and demerits, since it is not sufficient that such a work should be good and useful to justify its existence; it should be better and more useful than its competitors. But as there is no other work in Spanish which at all approaches this one in completeness, it would be a work of supererogation to point out wherein it might possibly have been better yet, in the reviewer's opinion, or to question the judgment shown in devoting space to this matter rather than to that. The work is a very complete field-book in Spanish, and the only one in existence. This should be enough to commend it to all Spanish speaking engineers.

Dynamics of the Sun.—Theoretical Astronomy, Woodbridge School Essays, No. 1. By J. WOODBRIDGE DAVIS. New York, D. Van Nostrand Co.. 4to, pp. 156, illustrations.

This is a complete edition of Series No. 1, promised in our previous notice of these essays from the proof sheets. While the matter is not of a nature that will admit of any brief review, the concluding chapters on planetary electricity are most interesting to the student of these phenomena. They discuss the electric tides, grand currents, magnetic phenomena, atmospheric electricity and cometary atmospheres.

—How to Become an Engineer.—The Theoretical and Practical Training necessary in fitting for the Duties of the Civil Engineer; the Opinions of Eminent Authorities and the Courses of Study in the Technical Schools. By GEORGE W. PLYMPTON, Am. Soc. C. E. New York, D. Van Nostrand Co.; 16mo.; pp. Science Series No. 100. 50 cents.

This is an excellent little book, answering questions received almost daily from aspiring young men. Mr. PLYMPTON gives the practice in America, England and on the Continent, and also indicates the range of study and the knowledge required by the different governments before granting to the student responsible charge of work.

—The Sextant, and Other Reflecting Mathematical Instruments, with Practical Hints, Suggestions and Wrinkles on their Error, Adjustment and Use. By F. R. BRAINARD, U. S. N. New York, D. Van Nostrand Co. 16mo.; pp., 33 illustrations. 50 cents.

A very useful work, treating of the sextant from its earliest to its latest form, and the best methods of handling it, and concluding with descriptions of the box sextant, reflecting circle, dipsector and artificial horizon. It is in handy shape, and clear in its language and illustrations.

—The Mechanical Errors in the Common Theory of Flexure.—By R. H. COUSINS, C. E. Austin, Tex. Pamph., 31 pp.

The writer, who is also the author of "The Strength of Beams and Columns," which has met with some adverse criticism, in this pamphlet sets forth his views on this subject, and in turn criticises the "common theory of flexure."

—Report from the Public Works Department (South Australia) for the Year Ending June 30, 1890. A. B. MONCRIEFF, Engineer-in-Charge. Paper, 8½ × 13¼ ins.; pp. 79, and several large folding sheets of diagrams, maps and illustrations.

The public works under the charge of the department include water-works for city and country supply, the latter including irrigation works and the conservation of water, sewers, harbors, jetties, lighthouses, roads and bridges, and public buildings. Railways also come under the supervision of the engineer of the department, but the report concerning them is made to the Railway Commissioners. The Engineer-in-Chief has charge of the engineering details of construction and maintenance of railways, water-works, harbors, fortifications and roads, aside from those in charge of local authorities.

A large part of the report is taken up with the detailed account of the year's work, but brief descriptions are presented of the water-works and sewerage systems, and of the irrigation and water conservation works.

A large map, in colors, shows the works under the Engineer-in-Chief's department. Several diagrams are given to show the strata pierced by artesian wells and the depths at which water was found or the boring abandoned. A colored diagram shows improvements made to the Fort Adelaide River, a section through the centre of the river being given. The report also gives the ground plan of the Adelaide and Port Pirie hospital, ground plan of a reformatory building for girls at Edwardstown, and a plot of a new cemetery at Salisbury.

SOCIETY PROCEEDINGS.

New England Railroad Club.—At the meeting on Oct. 14 the subject discussed was "Car Lighting." Mr. F. D. Adams outlined the past history of car lighting methods and praised the modern oil lamps. The Boston & Albany tried electric lighting for two years at an enormous expense, and did not get much improvement in the light. The Pintsch gas light is probably being introduced to a greater extent than any other, and it is an excellent light. He gave memoranda of the cost of lighting by different systems as follows: In 1876, when candles cost 24 cts. per lb., the cost of lighting by candles was 0.59 ct. per hour per candle. At that time mineral sperm oil cost 55 cts. per gall. and the cost per lamp hour was 0.64 ct.; but the lamp gave about 8 times as much light as the candle. As this oil costs now only one-seventh as much, the cost per lamp hour would be only about .09 ct. The Sherburn lamp made by Page Bros. & Co. gives 60 or 70 C. P. per burner and costs 0.18 ct. per hour per burner.

"The average cost of lighting 12 cars with 116 four-flame lamps (464 flames) for 7 months, from Dec. 1 to June 30, furnished with Pintsch gas, was $185 66 per month, the highest being for December, $280.65, and the smallest being for June, $84.28. The average consumption of gas per hour for each flame was 1.65 ft., the average cost for each was 0 83 ct. per hour. You will see that the average cost of the gas is about four times that of oil, with no more light for the same number of flames; but there are some great advantages in the gas over the oil, it being entirely clean, while oil is liable to drop on the seats and clothing of the passengers. There are no smoky lamps, no smell of oil, the lamps cannot be manipulated either by trainmen or passengers, and there is a uniform, steady light. It is impossible to get men to take care of oil lamps as they should be cared for; to make them clean and neat they require much care and time, while gas is no trouble at all; you simply turn it on and it is regulated as to the flame just as you choose."

Mr. Lauder said that the first cost of oil lamps, Sherburn pattern, was $165 per car. The cost of Pintsch gas equipment was nearly $400 per car. This, however, includes two tanks to each car, also platform lamps and closet lamps.

Mr. Dixon said Mr. Adams figures for running expenses were correct. Statistics from 4 roads using Pintsch gas showed an average cost per lamp per hour of 0.82 ct. The first cost of the lamps, however, is just about the same as that of the best class of oil lamps.

Mr. D. J. T. Oldham said that any system of lighting could supply light enough; but the distribution of the light was an important matter. The greatest obstacle to the rapid introduction of the Pintsch system in earlier days was the promise held out by electricity of becoming available for car lighting; but there are three large American railways now using Pintsch gas where they formerly used electricity.

Mr. Lauder said that one objection to the Pintsch system was the large number of charging stations required to supply a road of many branches, like the Old Colony. The Frost carburetter system has the advantage of being applicable to any car under any conditions and of carrying its own material with it.

"The Frost system uses gasoline, a very inflammable material, and many object to it as too dangerous; but we use things in our paint shops quite as dangerous, and, with reasonable care in handling, it is safe. Another serious objection to it is that it requires a great deal of care and an intricate knowledge of the system. When properly run it gives the most beautiful light I ever saw in a car—brilliant, soft and intense."

The Pintsch system has to be well made and put up to stand the high pressure employed without leakage. An objection to oil lamps is the heating of the roof of the car. We should have to admit that there is more danger of fire from oil lamps in case of collision than from Pintsch gas; but I know of no well authenticated case where a fire has been started in a railway wreck from lamps filled with 300° test oil.

Mr. Coghlan said he was using about 100 central-draft oil lamps and had for three years been experimenting to get a ventilator to carry off the heat. After succeeding in this he found that the strong draft would break the chimneys on very cold or wintry nights.

Mr. Chamberlain: I believe that with an oil lamp with proper oil, there is no more danger of setting a car on fire than there is danger of a Baker heater setting a car on fire.

Mr. Butler: Some years ago we made an estimate of the comparative cost of lighting by Pintsch gas and by oil, and it resulted in favor of the gas for maintenance, and everything, including the interest on the plant. The cost of fitting a car for lighting with Pintsch gas we have estimated at $350.

Mr. Lauder: "It is not entirely a question of how much oil is burned in the ordinary car lamp, or how much gas is burned under the Pintsch system. It is the question of maintaining the light in the cars with the two systems. Now, I believe that the furnishing of material and the maintenance of the light and the lamps in the car, including the payment for silk dresses ruined by oil, would make in a series of years the Pintsch cheaper to maintain than any oil light we have ever had."

At the next meeting the subject will be, "Care of Steam Heated Cars at Terminal Points." At that meeting a by-law will be acted upon making the meetings occur once in two months, instead of monthly, as at present.

American Society of Civil Engineers.—At the meeting on Oct. 21 Mr. George W. Rafter read a paper on "The Hydraulics of the Hemlock Lake Conduit of the Rochester, N. Y., Water-Works." These works include a domestic supply by gravity from Hemlock Lake, and a supply by direct pressure from the Genesee River for fire purposes. Hemlock Lake is 385.6 ft. above the city datum and 29.5 miles from the city. The Mt. Hope distributing reservoir is 1.4 miles from the city and 124.4 ft. above the city datum. The Rush reservoir, for additional storage, is 8.72 miles from Mt. Hope and 117.4 ft. above it. The lake is 19.2 miles from the Rush reservoir and 143.8 ft. above it. The pipe-line from the lake is of 36 and 24-in. wrought iron pipe and 24-in. cast iron pipe; the grades are 0.411 per 1,000 and 2.26 per 1,000. Between the reservoirs is a 24-in cast iron pipe line, with a grade of 2.51 per 1,000. The Mt. Hope reservoir stores 22,500,000 galls. and the Rush reservoir 70,000,000 galls., while the pipe line was said to deliver 9,700,000 galls. per 24 hours. In the warm weather of June, 1890, the storage became alarmingly low and Mr. Rafter was instructed to investigate the matter, and the actual delivery was found to be only 6,700,000 galls. per day. Piezometric measurements were then taken to ascertain the reason for this difference. The excessive resistance in the pipe line is mostly confined to the wrought iron section, that in the cast iron being such as might be expected in pipe a long time in use. At several places the rate of grade is much higher than the normal, and work of an unsatisfactory character has been testified to by witnesses. The tests throw doubt upon the original determination of 9,700,000 galls., and the indications are that the present flow has not been exceeded for many years, if at all.

The secretary read a long discussion from Mr. Emil Kuichling, but further discussion was stopped on account of the new plan adopted of ending discussions at 21 o'clock at the second meeting of each month, as noted in our issue of Oct. 10. Mr. Rafter has another paper on this subject, "The Measures for Restricting the Use and Waste of Water in Force in the City of Rochester, N. Y.," which, with general discussions, will be presented at the next meeting, Nov. 4.

Engineering Association of the South.—At the meeting at Nashville, Tenn., Oct. 7, the subject of the series of tests of American woods, recently inaugurated by the U. S. Department of Agriculture, and now being carried out at St. Louis, Mo., and Ann Arbor, Mich., was discussed. The secretary was instructed to communicate with the Secretary of Agriculture, expressing the interest taken by the association in this important undertaking and urging that the necessary appropriations be secured for fully carrying out the series now undertaken. A paper on "The Estimation and Measurement of Earth Work" was read by Mr. W. B. Ross, of Nashville. The paper, after a general analysis of the requirements and difficulties of earthwork estimation presented a comparison of the several methods now in use for determining volumes, expressing the error of the several methods as compared with the geometrically rigorous prismoidal formula. One of the conclusions was that owing to the fact that earth work excavations are usually bounded by a concave profile, either in the road bed cuts or in borrow pits, the prismoidal formula gives results less than actual volume taken out by an amount approximating to the error of success of the method of "averaging end areas," and therefore the latter was believed to be a more accurate and just method of estimation than the prismoidal method, which, while giving results rigorously true for the imaginary solid on which it is supposed to be applied, still gives results too small when applied to the usual form of earth solid, which is rarely a prism, but usually has a middle section larger than that assigned it in the prismoidal treatment. The author presented for inspection some tables devised by himself for rapidly taking out the volumes of "three level" ground and also exhibited some graphical scales for the same purpose and to be used in finding the center of mass of an excavation.

American Society of Mechanical Engineers.—The following officers for the ensuing year are nominated:

President, Chas. H. Loring; Vice-Presidents, (term expire at annual meeting, 1893), G. I. Alden, E. F. C. Davis, I. M. Scott; Treasurer, (term expire 1892), William H. Wiley; Managers, Jas. M. Dodge, Robert Forsyth, Jesse M. Smith.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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GEO. H. FROST..... .....BUSINESS MANAGER

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Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

COMING TECHNICAL MEETINGS.

Civil Engineers' Society of St. Paul.—Nov. 2. Secy., C. L. Annan.
Engineers' Club of Kansas City.—Nov. 2. Rooms, Baird Building. Secy., H. Goldmark.
Boston Society of Civil Engineers.—Nov. 4. Secy., S. E. Tinkham, City Hall.
Western Society of Engineers.—Nov. 4. Secy., J. W. Weston, 280 La Salle St., Chicago.
Engineers' Club of St. Louis.—Nov. 4. Secy., Arthur Thatcher, Room 901, Odd Fellows' Building.
American Society of Civil Engineers.—Nov. 4. "Water Supply and Water Waste Prevention at Rochester, N. Y." Secy., Francis Collingwood, 127 East 23d St., New York.
Engineers' Club of Minneapolis.—Nov. 5. Rooms, Public Library Bldg. Secy., F. W. Cappelen.
Association of Civil Engineers of Dallas.—Nov. 6. Secy., E. K. Smoot, 803 Commerce St.
Technical Society of the Pacific Coast.—Nov. 6. Secy., O. von Geldern, 819 Market St., San Francisco.
American Society of Swedish Engineers.—Nov. 7. At 250 Union St., Brooklyn, and 347 North 9th St., Philadelphia.
Northwest Railroad Club.—Nov. 7. Rooms, Union Station, St. Paul.
Atlanta Society of Civil Engineers.—Nov. 10. Secy., Parker N. Black, Room 39, Capitol Block.
Denver Society of Civil Engineers.—Nov. 10. Secy., Geo. H. Angell.
Northwestern Society of Engineers.—Nov. 10. Rooms, Occidental Block, Seattle. Secy., E. H. Warner.
Civil Engineers' Association of Kansas.—Nov. 11. Secy., J. C. Herring, Wichita, Kan.
New England Railroad Club.—Next meeting, Nov. 11, at United States Hotel, Boston. Secy., F. M. Curtis.
Civil Engineers' Club of Cleveland.—Nov. 13. Secy., A. H. Porter, 50 Euclid Ave.
Engineering Association of the Southwest.—Nov. 13. Secy., O. H. Landreth, Nashville, Tenn.
Northwestern Track and Bridge Association.—Nov. 13. Rooms, Union Station, St. Paul.
Western Railway Club.—Nov. 17. Rooms, Rookery Building, Chicago.
Engineers' Society of Western Pennsylvania.—Nov. 17. Secy., J. H. Harlow, Pittsburg, Pa.
Engineers' Club of Cincinnati.—Nov. 19. Secy., J. F. Wilson.
New York Railroad Club.—Nov. 19. Rooms, Gilsey House.
Scandinavian Engineering Society of Chicago.—Nov. 19. Secy., T. G. Pihlfeldt, 118 Adams St.
Montana Society of Civil Engineers.—Nov. 21. Helena.

THERE are few readers of this journal, probably, who do not rise above partisanship in voting for the office of State Engineer at least, if they are entitled to vote in New York, and endeavor to vote for the best qualified candidate, regardless of his political affiliations. Professional *esprit* ought surely to be strong enough for this. They have a hard choice before them this year and we see no satisfactory recourse for them but to take to the woods. So far as their professional record can indicate, both the Democratic and Republican nominees are as unfit for the office as they well can be, and neither one of them is in any just sense of the term constitutionally eligible for the office even if elected, since he is not a "practical engineer" as the constitution requires. As the State Engineer has professional charge of the state canals, and is also *ex-officio* a member of several Boards for which engineering knowledge is desirable, there is plainly need that this constitutional requirement should be adhered to in the letter, if not in the spirit. Neither one of the nominees is known to us personally or professionally, nor can we find either name in the list of any engineering societies. But the alternate attacks and defenses which appear in the political press enable records of each to be determined with some certainty. Mr. VERPLANCK COLVIN, the Republican candidate, appears to have a creditable record as a surveyor in connection with the state surveys of the Adirondack region, but his friends do not even claim for him that he has ever had any connection with the design or construction of any class of engineering works, still less responsible charge thereof.

As for Mr. MARTIN SCHENCK, the Democratic candidate, his professional calibre is sufficiently indicated by the fact that 6 years ago he was appointed a rodman on the state canals, that he was more lately a kind of foreman on the construction of the Capitol approach, and that this year he has been engaged on the Hudson River improvements under one of the office engineers, Mr. WHITBECK. Whichever one of these precious candidates is elected, it would be a public service if some one would raise the constitutional requirements against him, and so enable Mr. JOHN BOGART, the present admirably qualified incumbent, to hold over. It would teach the politicians of both parties a needed and a wholesome lesson.

THE evidence is accumulating and becoming very strong that, however ugly and otherwise objectionable may be the trolley system, it furnishes a cheaper method of propulsion than horses in nearly all cases, however thin the traffic, as well as a much better service in many ways. Moreover, however strong may be the preference for storage batteries or an underground conduit which will do away with the unsightly wires and trolley, there is as yet but scant reason to regard these systems as effective competitors of the trolley. All trustworthy evidence as to the efficiency of and cost of electric trolley roads, therefore, has special interest just at this time, and such evidence is, we believe, contained in the paper which we abstract in another column. One caution is called for in regard to it. The records of first cost are to be accepted with much caution, for the reason that this item is so often an imaginary and highly variable one, based upon the amount of the stock and bonds outstanding, and only to a very small extent on actual cash expenditures. But this difficulty does not exist in regard to the comparative operating expenses, and we have no reason to question that these are fairly represented by the figures. A study of them will soon reveal why electric railways are so popular both for light and heavy traffic: about 75% of the expenses vary directly with the car miles run, whereas the fixed expenses of a cable plant are so large a proportion of the total that a tolerably heavy traffic is absolutely essential for a reasonable cost per car mile. We may admit that the cable system is the most suitable and economical of all for very heavy traffic, as it doubtless is, and yet the electric power remains the real alternative to animal power for the average street railway. We referred to the objections to overhead wire systems in our issue of Sept. 26.

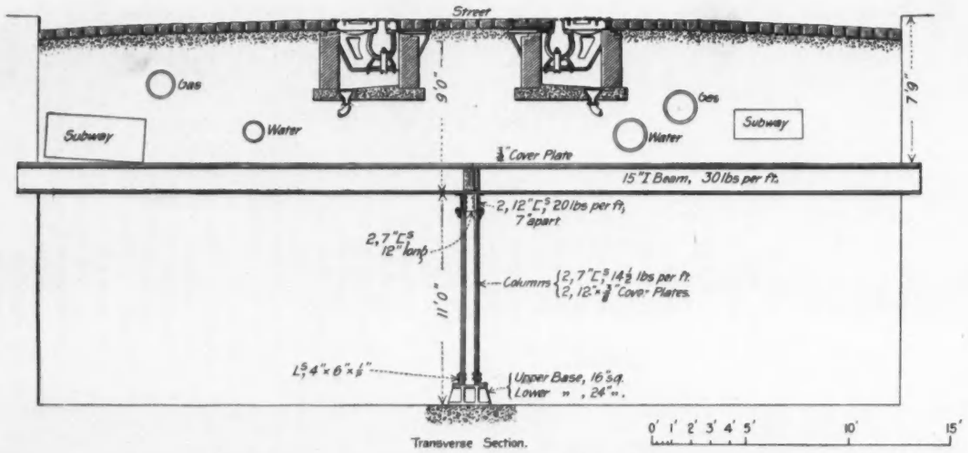
STREET improvements in California are made under a general law applicable to all corporations organized and existing for municipal purposes. The law is such a notable example of the advantages of general over special legislation, and contains so many features of interest to engineers and contractors connected with municipal work that a somewhat extended digest of it is presented elsewhere in this issue. Attention may well be called to some features of the law. A city council may order street improvements in any part of the city under its control, but must first declare its intention to do so, and in case the owners of more than half the street frontage enter a formal objection to the work action is barred for six months. Sewerage construction, however, is excepted from this provision, evidently in the interest of public health. All improvements must be made by contract, but after the council decides upon the successful bidder it must publish the name and prices, whereupon, if owners of three-fourths of the frontage affected so desire they may take contract away from the successful bidder and into their own hands. This might be a great drawback in securing bids were it not probable that advantage will never be taken of it, unless there is evidence of excessive jobbery in the letting of the contracts, a contingency which it seems designed to meet. On the whole it seems to be one of those harmless checks that might oftener be used by honest and intelligent legislators to prevent municipal corruption.

A FEATURE of the law which might prove objectionable is the provision that where the cost of improvements is met by assessment on property benefited the contractor collects his pay from the property owners instead of from the city. The advisability of such a course is questionable, as the contractor must add to his bid the cost of collecting the price of his work, and will quite likely add a percentage above actual cost for the trouble and delay caused him. It would seem that the city could collect the money at less expense and with less friction than the contractor, as its authorized agent would be permanent and probably better known to the people. However, the contractor can lose no money, as due process of law provided for in the act makes the assessment a lien upon the property and the property liable to sale as in case of delinquent taxes. Moreover, if not paid within a specified time the amount of the assessment thereafter draws 10% interest. In the case of heavy assessments, payable by property owners in yearly installments, the contractor receives a bond for the amount due, but the city collects the yearly payments and the interest due and pays the same to the bondholder, the bonds, as well as the warrants being of course transferrable. In general, the law, as will be seen upon perusal, seems well framed although it might be well to invest more authority in the street superintendent, and especially to give the city engineer more latitude, his only function under the law seeming to be that of a surveyor and draftsman of plans and specifications. However, there is nothing to prevent each city council from maintaining the city engineer's duties at a high level. What we would especially call attention to is the absence of special legislation which this law makes possible and which it is designed to supersede. It would be well for some of our Eastern States, notably Massachusetts and New York, to follow the example of California.

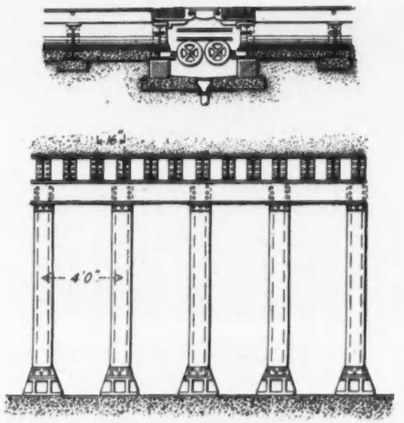
The New York Rapid Transit Report.

We give in full in another column, except for some formal verbiage, the final report of the Rapid Transit Commission, in regard to the route and general plans for the new rapid transit system which they are appointed to lay out under a law giving them unusually full powers and discretion. We also give in this issue a map of the routes selected, and as full drawings as are now available of the general plan adopted, which is, in its substance, that prepared by Mr. WM. E. WORTHEN. Our drawings also show the alternate plan which the commission submitted to its consulting engineers, prepared by Mr. W. BARCLAY PARSONS.

We are not disposed to take exception to a word or a letter of the commission's report. It is a pithy and able document. The route and plans they rec-

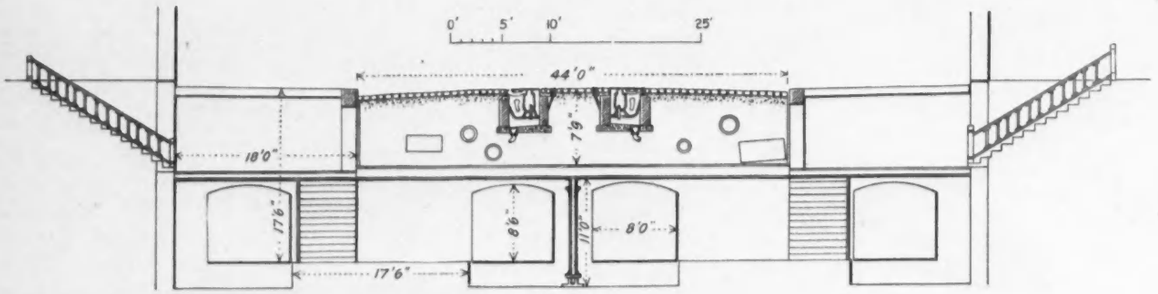


Transverse Section.



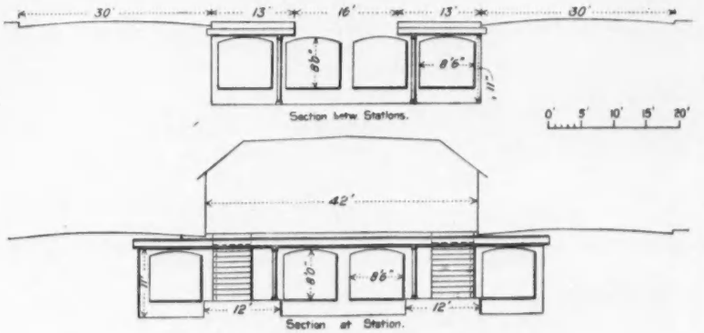
Longitudinal Section.

STANDARD SECTIONS OF BROADWAY LINE.



Section.

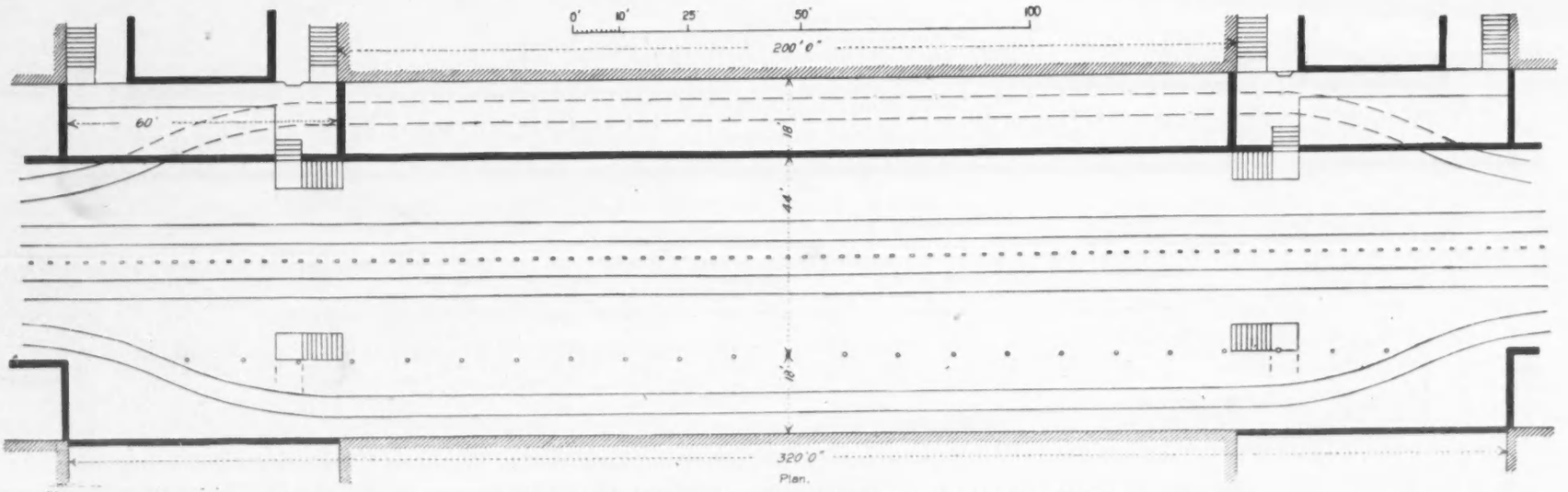
STANDARD LOCAL AND EXPRESS STATION ON BROADWAY.



Section between Stations.

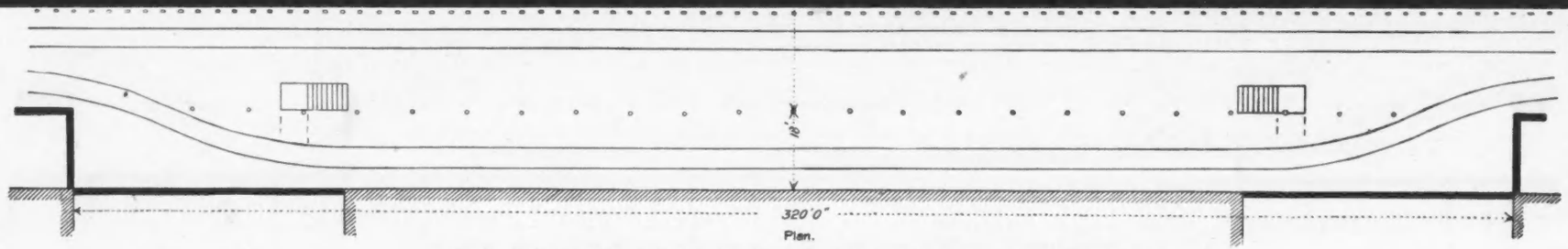
Section at Station.

BOULEVARD (59th to 181st Street).



Plan.

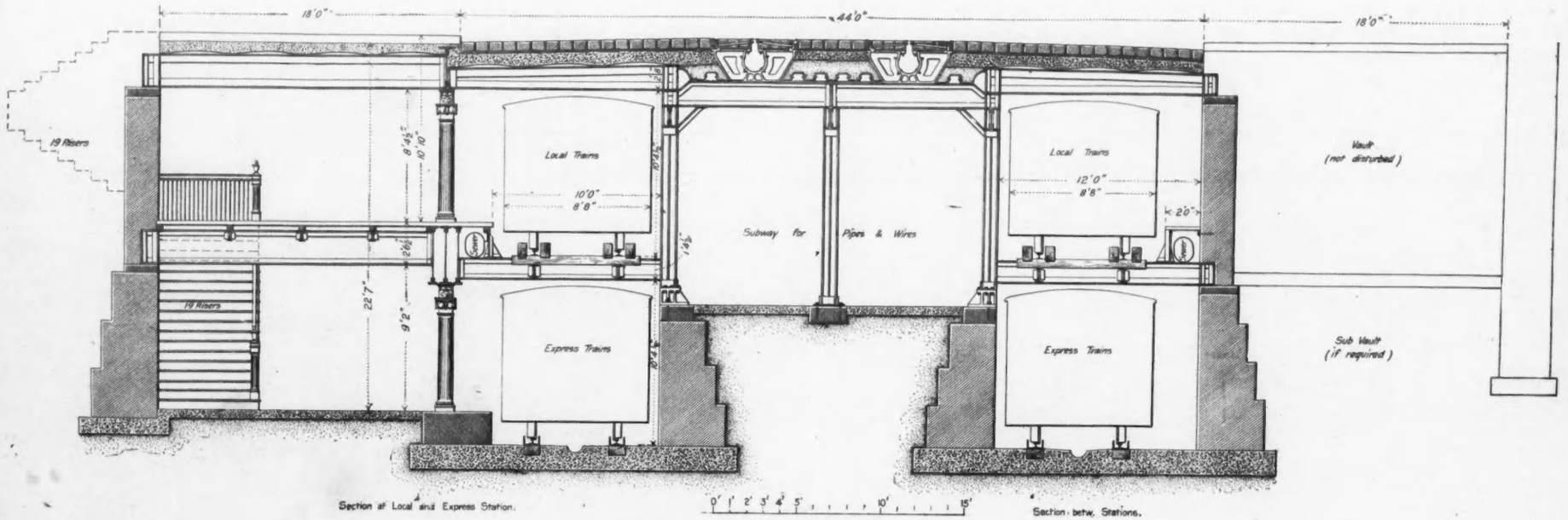
UNDERGROUND STATION ON BROADWAY, BELOW THIRTY-FOURTH STREET.



Plan.

LOCAL AND EXPRESS STATION ON BROADWAY, BELOW THIRTY-FOURTH STREET.

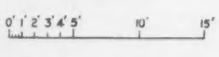
PLANS SUBMITTED BY WM. E. WORTHEN, CHIEF ENGINEER.

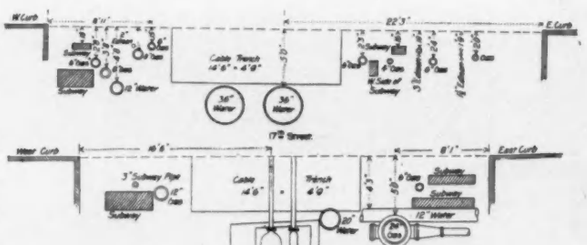


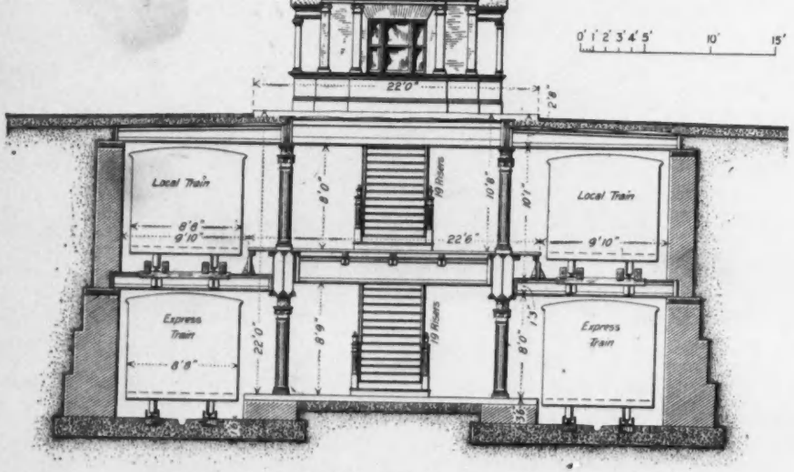
Section at Local and Express Station.

Section betw. Stations.

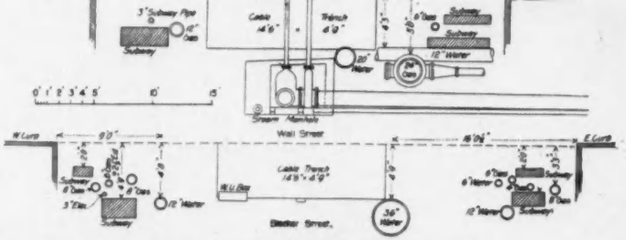
STANDARD SECTIONS OF BROADWAY LINE



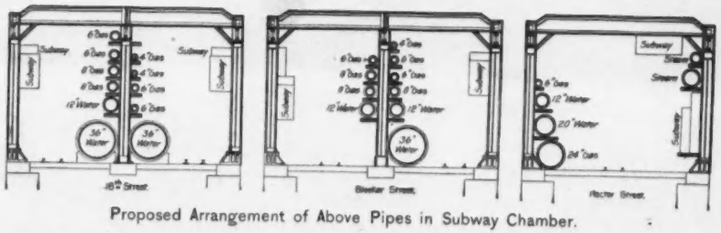




LOCAL AND EXPRESS STATION ON BOULEVARD.



Present Arrangement of Pipes and Electric Subways on Broadway.



Proposed Arrangement of Above Pipes in Subway Chamber.

PLANS SUBMITTED BY W. B. PARSONS, PRINCIPAL ASSISTANT ENGINEER.

PLANS FOR THE NEW YORK CITY RAPID TRANSIT RAILWAY, SUBMITTED TO THE RAPID TRANSIT COMMISSION BY ITS ENGINEERS.

ommend will probably be of at least as much advantage to New York, if carried out, as any other which could have been chosen. We have thought very highly of the plans prepared by Mr. PARSONS, which had plainly been very carefully studied, and had many strong points in their favor, as well as some against them which the commission correctly point out. We have also a high opinion of still other types of rapid transit construction, as notably of what has come to be popularly (and very justly) called "the Greathead system," which latter is very much more than a mere system of shield tunneling through clay or earth, as some journals which should know better have absurdly alleged. On the contrary, that system as now understood is a singularly novel and meritorious system of rapid transit of general application to all materials; and in our judgment it is destined to very extensive future use, in its substance, in this and other great cities, on certain kinds of lines for which it offers special advantages.

But while appreciating the merit of this and other types of construction, we are disposed to believe that the commission have made the wisest choice which they could have made for the line to be now constructed, both as to route and plans. Even had this not been so, we should have hesitated long before opposing their conclusions. Disputing over the particular plans to be adopted in a case like this is very much like haggling over the famous question: Which is best; roast beef or roast mutton? Either is best, and neither is. Whichever is best cooked is best. There are at least a dozen different types of rapid transit railway, from one a hundred feet above the surface to one a hundred feet below it, which are entirely practicable in an engineering sense, and any one of which would be a great boon to New York if carried out. The commission in its wisdom has prescribed for us an excellent piece of prime roast beef, and on the whole we rather prefer beef. The only question of real pertinence now is, whether an oven can be found big enough to cook it in. Should it prove impossible, we may wish hereafter that the prescription had been for mutton instead of beef, but we fully believe the oven will be forthcoming. In other words, while the plan recommended will perhaps be the most expensive of any, it should also, when completed, offer a shade better service than any other for an equal mileage, and the only serious question remaining is whether the money for construction will be forthcoming.

For another reason it would be worse than useless to quibble long over the commissioners' choice, even if in some respects questionable. They have not even decided between roast beef and roast mutton as a finality, but merely between beef to-day and mutton to-morrow, *or vice versa*. There is nothing to prevent the future construction of other routes on other plans, when and as necessity for them appears, and capital stands ready to construct them. And it is a distinct step in advance to have the question reduced to one of Hobson's choice, roast beef or go hungry, rather than to have the public confused by clamorous advocates of every different meat in the market, with an end, perhaps, like that of the Kilkenny cats.

Not the least merit of the report is its brevity and pithiness. No necessary point is passed over, but no words are wasted. Enough space is taken to clearly state the reason for each successive conclusion, and nothing more. Brief as is the report, however, it is an amusing sign of the times that several leading journals are unable to give space for the whole of it. Most of them give more prominence to the lowering of the trotting record by Sunol, by half a second, than to the report, and all of them give more space to trashy political matter relating to the approaching election. But we are pleased to note that without any important exception they appear disposed to approve the report, and to favor prompt construction on the recommended plans.

The gravest remaining question is, Will the capital for construction offer? We cannot doubt that it will. The commission justly points out that the city traffic grows heavier as the lines lie nearer to Broadway. The situation seems to make it very clear that, quite independently of other existing lines of transit, enough passengers will find this line more convenient than any other to give it an unprecedented traffic per mile of track almost from the beginning. The mean net earnings of the entire Manhattan elevated systems are now at the rate of about $125,000 per mile of double track; on the Sixth and Third avenue lines only they are at the rate of about $160,000 per mile. This is at the rate of $250,000 to $320,000 per mile for a four-track railway, which would pay interest at 6½ per cent. on $4,000,000 to $6,000,000 per mile. The probable cost of the road complete should be considerably less than $4,000,000 per mile on even the most costly section. It is fortunate that the most costly section is also that of heaviest traffic. There appears to be sufficient margin to give assurance of moderate returns on the capital, with possible very large returns.

This may be shown more in detail as follows: Rudely scaling the distances from a map, and allowing what it seems to us should be the maximum cost per mile of the sections (being from 25 to 33 per cent. more than the common allowances), we obtain the following estimates of the cost of the line when fully completed:

Section.	Tracks.	Miles.	Cost per mile.	Total.
Battery-14th St....	4	2.6	$4,000,000	$10,400,000
WEST SIDE:				
14th-34th St.....	4	1.1	4,000,000	4,400,000
34th-190th St.....	4	8.0	3,000,000	24,000,000
190th St.-City line..	2	4.3	2,000,000	8,600,000
EAST SIDE:				
14th St-Harlem R..	4	6.4	3,000,000	19,200,000
Harlem R.-Van C. Pk.....	2	5.2	2,000,000	10,400,000
Total.....		27.6	$2,780,000	$77,000,000
Of which there is on Manhattan Island.....		18.1	$3,200,000	$58,000,000
And in the annexed dist.		9.5	2,000,000	19,000,000
Interest charge at 6%.....			{ Manhattan Island.	3,480,000
			{ Annexed district.	1,140,000
Present yearly net earnings, Manhattan Elev. system.....				4,000,000

The sections beyond the Harlem River will not be built for some years and may properly be left to stand by themselves. The system on Manhattan Island, estimated at $3,200,000 per mile and 4-track throughout, will involve an interest charge at six per cent. of only $3,480,000 per year, whereas the net earnings of the present elevated system is now some $4,000,000 per year. It is not likely, however, that the actual cost of the system will be nearly as large as that stated. When all proper allowances are made this showing seems to us quite sufficiently encouraging to insure that capital will be forthcoming under equitable conditions.

Nor can we believe that much delay will occur in securing the consent of the Broadway property owners. They have everything to gain and nothing to lose from its construction. The law provides the usual alternative to their consent by an appeal to the courts, but this involves delay, especially if the opposition be determined. In this case, if there be any opposition, it seems quite certain to be weak, half-hearted and ineffectual.

Under the law the Common Council has not less than one week nor more than four weeks in which to approve or disapprove of the plans. It is generally expected that the approval will be prompt. The commission has then to obtain the assent of a majority in interest of the property holders, or in lieu thereof of a commission appointed by the Supreme court. It is then to complete detail plans and specifications for construction, "including all devices and appurtenances *deemed by it necessary to secure the greatest efficiency, public convenience and safety*, a very broad clause which, if wisely availed of, will insure advantages to the public which might not be secured from any private company left free to prepare its own plans. The commission is then to prepare and advertise terms of sale, for doing which the law gives it broad discretionary powers, and to sell the franchise at public auction "for the account and benefit of said city." As we understand it, the commission has authority to stipulate what form the "benefit" to the city shall take, whether of a gross sum in cash, or a percentage of the stock, or a percentage of the gross or net profits; but this condition being once fixed, the competition is to be open to all at public auction.

The terms of sale are required by law to provide for the organization of a *new* corporation, under conditions which we need not now review in detail, but which oblige it to fully commit itself to carrying out the specific plans elaborated by the commission, and to act throughout under the supervision and control of that commission. The latter is not obliged to accept the lowest bid, but may take "that bid which, *under all circumstances*, in its opinion is most advantageous to the public and said city." The commission is also to fix the period for construction of the several parts of the system, and approve the articles of association of the corporation organized. It is also empowered to fix the amount of capital stock and bonded debt of the company, and to control the books of subscription for stock, which are to be publicly opened at an advertised time and place. As soon as the stock has been subscribed for by not less than 50 persons the commission is to call the meeting for organizing the corporation. Should there be any slip in any of these proceedings the commission has power to revise any of its plans and conditions and begin *de novo*, while it is a continuing body after the organization of the constructing company, and is required to exercise a continuing supervision over all the acts of the corporation affecting the public interest. For example, the latter has no power to increase its capital stock except with the approval of four out of the five rapid transit commissioners. Most of the more important acts of the commission are required to be by a like majority.

These provisions, with many others not noted, practically place complete control of the rapid transit problem in the hands of the commission, provided only that capitalists are forthcoming to carry out what they recommend under the conditions which they fix. It is well that there should be this concentrated responsibility. Should there be any failure to get some plan under way within a reasonable time, the public will know where to place the responsibility. Should it at any time appear that private capital is not forthcoming to carry out the commission's plans, and an appeal be made for public funds to do so, then the most jealous and critical scrutiny of all its plans will be in order. Until then we do not perceive that the public need concern itself with details further than to assure itself that they will, if carried out, give thoroughly excellent means of transit, as good as or better than any others which seem reasonably feasible.

This the plans proposed certainly will do, in our judgment, as already stated. Therefore we refrain for the present even from mentioning certain details in which it seems to us that improvement in the recommended plans may still be possible. Should we do this at some later date it will only be by way of suggestion, not of criticism, and only after further study than we have been disposed to give to the matter before the final conclusions of the commission were made known. We may say now, however, that it is an unfortunate feature of the plans proposed that they do not make incidental provision for placing the pipes and wires now beneath the street in accessible subways, as did Mr. PARSONS' plans, and it is not yet entirely clear to us that this cannot be provided for under the plans recommended without serious change in

their substance or serious increase of expense. At any rate, this possibility should still have earnest attention in working up the details, to the extent at least of taking care not to throw new and needless obstacles in the way of the future construction of such subways.

Time-tables and Realities.

It is a common and (to some extent) just subject of complaint against railways that "time-tables and realities" are so often at variance with each other, a considerable percentage of the trains of all railways arriving some minutes or hours after their scheduled time. The English Board of Trade has for some time past been taking the most effectual possible means for remedying this evil by collecting the facts in regard to it and publishing the returns in much detail. These returns we reviewed at some length in our issue of Nov. 1, 1890, regretting then, as we must now, that no similar returns were available in this country, by comparison with which the comparative merit of English and American practices in this important detail could be estimated.

A reporter of the New York *Evening Post* made last week a very slight contribution to this subject by making a return of his own observations on 8 successive days on the trains arriving at the Grand Central Station between the hours of 7:30 and 10:00 A. M. Within this period he found from 5 to (on one foggy day) 21 trains late daily by 5 minutes or more, and he adds the statement that "the whole number of trains arriving within the time of observation was 26," by which is evidently meant 26 trains daily.

This last statement would appear to be incorrect, there being no less than 28 trains scheduled to arrive between 8:00 and 10:00 alone—viz., 15 between 8:00 and 8:59, and 13 between 9:00 and 10:00, inclusive, in addition to which 7 are scheduled to arrive between 7:30 and 8:00.

Therefore, it would appear that these records really cover the arrivals of 30 to 35 trains daily, instead of 26, but, taking the statement as it stands, assuming that the observer had some basis of observation not explained, under which his statement is correct, the record makes by no means an unfavorable showing when contrasted with the English railway returns. To make this clear we have computed the percentages of delayed trains on the same basis as the English returns abstracted in our article of Nov. 1, 1890, and thus obtain the following comparison:

Relative Percentages of Delayed Trains among those arriving on 8 Mornings at the Grand Central Station, New York, and on Various English Railways during the Month of July, 1890:

	On time to 5 mins. late.	5 to 10 mins. late.	10 to 20 mins. late.	20 to 30 mins. late.	Over 30 mins. late.
Grand Central.....	57.7	21.9	9.7	5.4	5.3
English Railways:					
Great Eastern.....	84.1	9.2	5.1	1.2	0.4
Gt. Northern local	85.1	10.5	3.7	0.5	0.2
Gt. Northern Scotch	9.2	8.2	16.8	17.4	48.4
Gt. Northern Exp.	42.9	24.0	22.3	8.1	2.7
Great Western	73.9	13.0	9.8	9.2	1.1
Midland	54.7	21.4	15.9	3.7	4.3
Southeastern	70.8	16.0	9.1	2.3	1.8
L. C. & D., long dist.	40.5	24.3	23.8	7.8	3.6

Two facts are to be kept in mind in comparing these records which both tend in favor of the Grand Central record:

1. The Grand Central record was compiled by an unfriendly and irresponsible observer, who had chosen a brief period in the morning only of each day to make observations, and who had possibly chosen the days and hours to best suit his purpose, while his statement of the total number of trains arriving during his period of observation is apparently too small in any case.

2. Included in the Grand Central returns are at least two trains daily, the Montreal and Cincinnati express, which have runs of 384 and 867 miles respectively, and which have hence very few parallels in the trains covered by the English returns above, except the Scotch trains of the Great Northern Railway, which have a run of about 400 miles. Comparing these returns, it will be seen that practically half of the Scotch trains (48.4 per cent.) were over 30 minutes late, whereas only 30 per cent. (5 out of 16) of the Cincinnati and Montreal trains were over 30 minutes late.

The other trains covered by the record were what are called here "local" trains, viz., trains with 30 to 100 miles of run, but nearly all of the runs were longer than the so-called "long-distance" runs of the London, Chatham & Dover, for example, which can hardly have a run of over 60 miles on any part of its system. Bearing all these facts in mind it will be seen that the Grand Central record is slightly better than the L., C. & D., Midland and Great Northern "express" traffic, and not so greatly inferior to the best of the other records as to make the contrast specially notable or significant when the differences of conditions above noted are kept in view.

The Grand Central record is not of sufficient extent or authority to make it worthy of further discussion or analysis, but it does illustrate what we stated in our first sentence, that there are just grounds of complaint against nearly all railways in regard to the regularity of their service. Some roads offend more and some less, but that all offend somewhat more than is reasonably necessary, we may well believe. The question of real pertinence is: What is the remedy for the evil, so far as it is remediable, and to what extent is it irremediable?

The most obvious and natural conclusion from the facts is: Trains arrive late because they cannot make their time; therefore the schedule speeds are too high; therefore they should be reduced to such schedules as can certainly be lived up to. But this, as we have before had occasion to say in answer to a correspondent who advised this remedy, is most certainly a wrong conclusion. The locomotives can easily make their schedule time, unless they break down, in all but very rare instances, and slow trains are about as often late as fast ones, the length of run and not the rate of speed being the main factor in increasing the percentage of delay.

The real origin of the evil lies simply in these two facts: (1) Man is not a machine, and (2) Even railway machinery is not indestructible. The constant effort of all vigilant railway management is to make them as nearly so as possible, and in proportion to its vigilance the effort is successful, but on the other hand, the vigilance of every one of the thousands of men on whom the regular running of trains depends is in a constant state of "unstable equilibrium," so to speak, tending constantly to be a little less to day than it was yesterday. The problem is: What means will have most effect to continuously keep every mechanical and human cog in the great machine up to the highest attainable point of clockwork regularity? When that has been done, all has been done which can be done to insure perfect regularity of train service; for there will still remain a considerable residuum of delays from weather, break-downs of machinery and over-caution or under-caution of employés which no human skill can remove.

To state the problem in this way is at once to suggest the solution. Absolute perfection being out of the question, *comparative* perfection can alone be insisted on, as certainly attainable, and to insure such *comparative* perfection the first (if not the only) essential is a basis of comparison, in an accurate knowledge of what is actually accomplished on other railways or on the same railway at other times. Every railway can then reasonably be required to show cause why it is not doing as well as other lines, or as well as it has itself done heretofore, and thus the instinct of emulation is effectively appealed to, leading every officer and employee to do his best to show a good record, even without any other outside pressure than a bare statement of the facts.

For this reason we believe that there is no class of railway statistics which can be so usefully collected by public authority as the extent of irregularity in passenger train service, or for that matter of freight train service also, though the latter has never yet been attempted, so far as we know. The work which the English Board of Trade has been doing in this line has already resulted in quite a notable improvement as we shall shortly show in a separate article. From the very nature of the evil it is wholly irremediable by any direct interference or mandatory requirements, because there is no one single delay on any railway for which, if complained of, some apparent good reason could not be advanced. The one certain demand which can be reasonably made in every case is that there shall be no abnormal proportion of such occurrences: that one road shall do as well as another or show reasons why it cannot. This demand is silently made every time returns of this kind are published, and we may be very sure it will be duly heeded, when the records themselves are admitted to be fair and accurate. From the nature of the case, no one railway likes to give out such information alone; for there is none righteous, no, not one; but we believe that there would be no serious opposition to the collection and publication of returns from *all* the railways of a state or of the country, and we also believe that no work which would more certainly work good and not harm could be undertaken by public authority.

Mesquite block paving has been laid in San Antonio, Tex., for two years past and is said to be wearing very well. The mesquite is abundant throughout Southwestern Texas, the trees resembling old peach trees in their general appearance. The wood is very tough and durable. In laying the pavement the roadway is graded to the desired cross-section and well rolled with an Aveling & Porter road roller. Then a layer of concrete, 4 to 6 ins. thick, is laid and well rammed. Over the concrete is spread a sand cushion 1 in. thick and the mesquite blocks are laid on this. The blocks are made by sawing the round sticks of the mesquite wood into 5-in. lengths; the diameter of the blocks varies from 4 to 8 ins. The blocks are laid with the small end up. The total amount of this pavement which has been laid in the city is nearly 40,000 sq. yds., the cost of which has been about $3.00 per sq. yd. Under a contract now in force about 10,000 yds. more are to be laid. Doubtless the dry climate is favorable to the durability of wood paving.

The Trans-Siberian Railway, it is reported, will be pushed to completion in 1895, if possible. About 2,500 miles of the route has already been located, and 2,400 miles remains unsurveyed. The cost of the road complete, including equipment, is estimated at $175,000,000. The eastern terminus is Vladivostock, which is being thoroughly fortified. It is estimated that the line will from the first nearly pay interest and operating expenses, the probable tea and mineral traffic being large. The principal motive for construction, however, is of course, military. The line is of special importance, because if really pushed forward rapidly, it will be quite certain to force the Chinese to begin railway construction.

An unbreakable fly-wheel, says the *Revue Universelle*, is in operation at the Mannesmann Tube Works. This wheel, attached to a 1,200-HP. engine, has a cast iron rim, to which are securely bolted two steel disks 20 ft. in diameter. Around the circumference of the wheel are wound about 70 tons of No. 5 wire under great tension. The wheel makes 240 revolutions per minute, so that a point on its circumference travels at the rate of about 15,000 ft. per minute, or nearly 180 miles per hour. The plan seems simple and effective, and in view of the frequency of accidents from bursting fly-wheels—the last one at Manchester, N. H.—the problem is one well worthy of deeper study than is usually given it.

CORRESPONDENCE.

Abt Rack Railways in Japan.

PHILADELPHIA, Pa., Oct. 17, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of Aug. 29 there were given different Abt system railway lines in the world. Although it is not completed yet, we have a line of over 7 miles at the Usui Mountain, Japan. It is to connect the two termini at Yokohama and Karnisawa, both on the State Railways. The work was commenced last spring, and is expected to be completed in two years. There are 21 tunnels in the distance, amounting to over 12,200 ft. in all. The steepest grade is 1 in 15. The construction is under the Bureau of the State Railways. Mr. HOMMA, who studied in the United States, being the resident chief engineer.

C. KADONO, KOGAKUSHI.

Some Cattle Guards Which Failed to Guard.

INDIANAPOLIS, Ind., Oct. 13, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: There was a test of railway cattle guards here this afternoon under the charge of the road department of the "Big Four" system. There were five guards shown of the so-called surface guards and one of the old style pit guard.

The National Cattle Guard Co., of Chicago, had two guards; the Kalamazoo Velocipede & Car Co., one; the Shorthill patent sewer pipe guard, of Marshalltown, Ia., one, and the Bush Cattle Guard Co., of Kalamazoo, one.

The guards were put in side by side and then a drove of 16 cattle were turned into a small pen on one side so that to go out they would be obliged to cross one or the other of the guards. The result was that one of the National Co.'s guards was crossed first, then the Shorthill sewer pipe guard was crossed by three head of cattle at once. The third guard attempted was that of the Kalamazoo Velocipede & Car Co. The cattle crossed and returned back over it again with perfect ease. After that the guards were all closed up, except one of the National guards and the Bush surface guard, of Kalamazoo.

In a very few minutes three head of cattle had crossed the National and two head had crossed the Bush, leaving only the pit guard that had not been crossed by one or more head of cattle.

All of the surface guards were then closed and in a few minutes two head of cattle had crossed the pit. Consequently the railway companies can choose from six different guards that allowed stock to cross with ease.

The guards were all fairly placed and the trial fair, except the cattle were of that class that are used to feeding in the outskirts of a city and are great hustlers after feed.

I will not attempt to draw any conclusions, but will leave it for you or your readers to do so if you care to attempt it.

A CIVIL ENGINEER.

Priority of Invention in Car Lamps.

BROOKLYN, N. Y., Oct. 19, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I notice two communications in your issue of Oct. 17, one from the Adams & Westlake Co., and the other from Mr. J. KIRBY, Jr. The former claims to be the pioneer in using large oil burners, and the latter puts his burner into use, according to his dates, in 1877 or 1878. The Adams & Westlake Co., by their own statement, did not begin the introduction of oil burners until about eight years later. In this connection I would say that I made a center car lamp with a *headlight* burner in the year 1868 (I am positive as to the date).

At this time candles were in almost universal use on cars. Mr. ALBERT PULLMAN said to me that he was tired of candles and wanted more light. I made the center car lamp (using lard oil for the burning fluid), and called Mr. PULLMAN'S attention to it. I also showed it to Mr. LONGSTREET, Mr. PULLMAN'S master car builder, and to many others at different times during the year. Everyone seemed to think the light was too powerful, that it would affect the eyes. I therefore became discouraged and abandoned the invention. The lamp I had made hung in the shops of Dane, Westlake & Covert until it was destroyed in the great Chicago fire.

During the years 1868 to 1871 I took out a number of patents on car lamps, almost all of which were universally adopted by the railways. The firm of Creer & Adams, to which the Adams & Westlake Co. is successor, brought out similar lamps in 1873-4.

The Adams & Westlake Co. are mistaken in their reference to the manner of raising the wick in the Belgian burner. The device is new and novel. Again, the Belgian burner does not really need a drip cup. I have seen this burner used for days in my car lamp and no oil in the drip cup; and in my two years of experimenting I never had a chimney break or turn white while in use.

WM. WESTLAKE.

Wooden Water Supply Conduits.

DENVER, Col., July 23, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

DEAR SIR: I have been much interested in your recent articles on wooden water pipe, as it has always been a hobby of mine that it was advisable in a gravity supply for a growing city to use a wooden conduit. I have also had a good opinion of its lasting powers, as I saw some tamarack logs, bored, taken up in Detroit about 20 years ago which were said to have been laid by the French about 100 years previous. The pipe had been unused for many years, yet the wood was bright and free from decay or any fungoid growth whatever. Of course this is not the sort of pipe we use in this region, but it showed that wood, under those circumstances, would not decay or become foul.

Then we have the testimony of Mr. J. T. FANNING, as quoted by Mr. A. McL. HAWKS in ENGINEERING NEWS of June 13, 1891, that a wooden main 6 ft. in diameter and 14 years old had always been found to be clean on the inside. There was also the testimony of Mr. B. H. HULL in the succeeding issue of your journal as to similar mains in use for 40 years. There is a wooden pipe in this city, 4 ft. in inside diameter, used by the Denver Water Co., which has been laid some 6 years and has run from full to half full of water most of the time, which would seem to be a trying situation, and this shows no sign of decay or fungoid growth.

Mr. S. FORTIER, of the water-works at Ogden, Utah, writes under date of March 12, 1891, regarding a wooden conduit, as follows: "It is now three months since water was first let in, and we have not caiked a leak or repaired a defect of any kind, to my knowledge, since the third day after turning on the water."

A report was recently made by the superintendent of a mining company at Idaho Springs, Col., that their 22 in. pipe was crushed by falling rock, but as they had some extra staves on hand they had the damage repaired and the water turned on again within two hours. This is but one of the many instances where dollars have been saved by the ease with which wooden pipe can be repaired. In ENGINEERING NEWS of January 17, 1891, is an extract from Mr. JAMES D. SCHUYLER'S report on the proposed works of the Pueblo Gravity Water Supply Co., in which he most warmly commends the pipe.

The above are such authorities as I can recall or gather this evening. This communication is written to call up this matter, and ask you or your readers to contribute any information they may have regarding the failure of wooden pipe. It is from failures we learn, and the pipe must in some cases fail, as the inclosed slip seems to show. The slip is from one of the Denver daily papers, and gives extracts from a report of Mr. D. W. CAMPBELL, one of the oldest and most widely known of Denver's engineers. Mr. CAMPBELL must have reason for such condemnation. Let us get at the circumstances surrounding the failure of wooden pipe that we may avoid like results in our own practice.

A. M. VAN AUKEN.

[The clipping enclosed with Mr. VAN AUKEN'S letter states that Mr. D. W. CAMPBELL had recently reported on the wooden water-supply conduit of the new company, and quotes from his report. The company referred to is the Citizens' Water Co., a rival of the Denver Water Co., which is now developing a gravity supply in connection with which several miles of wooden conduit are to be used. The parts of the report referring to wooden pipe are as follows, the separate sentences, except the last two, evidently having been taken from different parts of the report:

I think the construction of 17 miles of wooden conduit a great mistake and one which will entail great financial loss to investors, because it is shortlived, leaky, and in a year or two foul and contaminating to the water. The pipe is very shortlived when buried under ground. The rapid and enormous growth of fungi in these pipes whenever for any cause the pipe is emptied for a few days is so rapid that the friction would be greatly increased in the pipe 24 hours after emptying. This defect is also the cause of contamination of the water supply.

Although the comparative merits of wooden and iron pipe have been pretty thoroughly discussed in these columns and elsewhere it may be that additional light can be thrown upon the question by some of our readers. If so we shall be pleased to hear from them.—ED. ENG. NEWS.]

A MOTOR CAR PRODUCING ITS OWN ELECTRIC CURRENT has been designed by Herr HEITMANN, an Alsatian engineer. He uses a triple expansion engine on the motor-car, which works a dynamo connected with electromotors. He claims a speed of 7 to 8 miles per hour, with less oscillation, and the power to more easily overcome grades. He presents no figures of cost, but proposes to pull a train of cars, using his motor-car as a locomotive in fact.

The Plans for the New York City Rapid Transit Railway.

(WITH INSET.)

Upon our inset sheet this week we show the plans submitted by Messrs. WM. E. WORTHEN, Chief Engineer, and W. B. PARSONS, Principal Assistant Engineer, to the New York City Rapid Transit Commission, for an underground railway upon the routes heretofore laid down by the Commission. These drawings should be studied in connection with the reports of Messrs. WORTHEN and PARSONS to the Commission, published in our issue of Oct. 10, and with the drawing showing the method of construction of the lower Broadway section proposed by Mr. WORTHEN, which was published with accompanying description in our last issue.

Besides these drawings, we publish herewith the most important of the drawings accompanying the general plan of construction adopted by the Commission and submitted by them to the City Council for approval. It will be seen that the Commission has practically adopted the Worthen plan, which has four tracks on one level and which leaves the present pipes, sewers and subways intact in the street. While for a full description of the types of construction shown on our inset sheet, reference should be made the reports of the engineers by whom they were designed, the following are the chief points of interest in connection with each system of construction:

THE WORTHEN FOUR TRACK LEVEL SYSTEM.

As shown by the drawings, Mr. WORTHEN proposes to drive a rectangular four-track tunnel under Broadway with its roof 9 ft. below the level of the street. The tunnel is to be roofed with iron beams resting on the sidewalls and on a central longitudinal stringer supported by a row of columns. The drawing as submitted by Mr. WORTHEN to the Commission does not show the dimensions of the members in his proposed construction, but for clearness and convenience we have added the dimensions of the members as designed by Mr. Mr. L. L. BUCK, M. Am. Soc. C. E. at the request of Mr. WORTHEN, and submitted to Mr. WORTHEN in the following report, dated July 20, 1889:

I submit below sketches and dimensions of members to support the material and moving loads which are to rest on top of the tunnel shown in your tracings.

In making these calculations, I have taken 7 ft. depth of sand at 130 lbs. per cu. ft., 20 ins. of pavement at 150 lbs. per cu. ft., and a moving load of 150 lbs. per sq. ft. The weight, with these dimensions, aggregates 55,440 lbs. per lineal ft. of a carriage way 44 ft. wide.

This road is assumed to be supported by a system of steel beams laid transversely to the street. The beams are to be covered on top with ⅝ in. × 16 in. steel plates, and are to rest on the two side walls and a single line of longitudinal girders under the middle, which in turn are supported by steel columns placed 4 ft. apart, center to center.

The transverse beams are 15-in. I-beams, weighing 50 lbs. per lineal foot, spaced 16 ins. apart on centers; each is assumed to be in two equal parts, with their abutting ends directly over the middle supports.

The longitudinal girders are formed of two lines of 12-in. channels, weighing 20 lbs. per ft., placed on edge, back to back, and 7 ins. apart in the clear. At points where the supporting columns connect with the longitudinal channels, two pieces of 7-in. channel are riveted between the longitudinals, the upper and lower ends of the 7-in. channels flush respectively with the upper and lower edges of the 12 in. channels.

The supporting columns are made of two 7-in. 14½-lb. channels, with two 12 × ⅜ in. cover plates riveted to the channel flanges. The head of the column is finished with an angle riveted to the top end of the 12 × ⅜ in. plates and forced to fit squarely the under sides of the longitudinal girders, to which it is secured by riveting the top angles of the columns to the flanges of the girders. The lower end of the column is prepared in the same manner as the top, excepting that 4 × 6 × ⅝ in. angles are used, with the 6-in. legs riveted to the 12 × ⅜ in. plates. The column rests upon a cast iron base 12 ins. high, the upper base 16 ins. square and the lower base 2 ft. square, to bear upon the masonry.

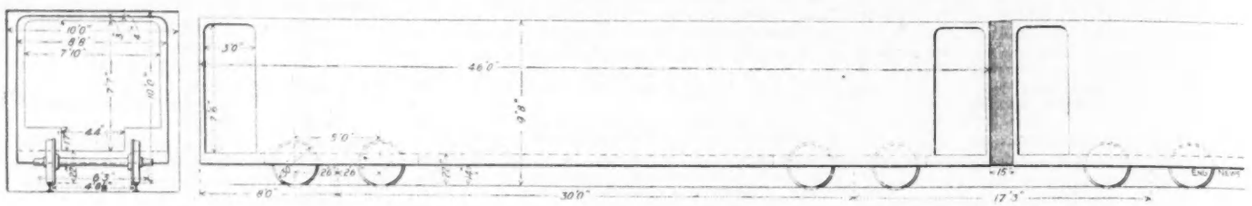
The deflection of the 15-in. I-beams under the assumed load would be at most 0.35 in. at their middle points.

The material above described would weigh about 3,100 lbs. per lineal foot of roadway, of which 131 lbs. would be cast iron.

The steel plates are to be protected from corrosion by injecting coal tar on the upper side during construction. The standard depth of the tunnel floor below the street level is 20 ft.; this is less than the

depth of foundation of most of the new buildings on Broadway and of most of the older ones which can be regarded as permanent. In constructing the tunnel it is intended to excavate without disturbing the surface of the street, or the pipes beneath it. The roofing shield or poling board system, proposed for accomplishing this, we described and illustrated last week. The initial excavation necessary for starting this shield is to be made from the vaults on each side of the street working toward the center always open for traffic, and not stopping the operation of the cable railway.

Upon the Boulevard Mr. PARSONS proposed to retain the double-deck system, placing the tracks in the center of the street and the stations between them, as shown by the drawing. The most interesting feature of Mr. PARSONS' plan, however, is the fact that it disposes of the pipes and electric subways beneath the street surface in a permanent subway chamber, and makes it no longer necessary



PROPOSED CAR FOR NEW YORK CITY RAPID TRANSIT RAILWAY. Designed by W. B. Parsons and D. L. Barnes.

without disturbing the surface of the street except along the curbs, where narrow trenches will have to be dug, in which the side walls of the tunnel will be built. To economize in the cost of excavation and expedite the work, it is proposed to excavate the tunnel at first only 6 ft. 6 ins. deep, as shown in the drawing published last week, supporting the transverse beams on temporary wooden columns. While work is being pushed on this heading, another gang a short distance in the rear will excavate the remainder of the depth, removing the excavated material on cars. Doubtless at the stations and perhaps at some other points, it would be necessary to excavate in open cut.

The standard section of the road at local stations would be practically the same as between the stations, the platforms being located on the outside of the local tracks and extending the length of a block and across two side streets. At the stations where both local and express trains stop, the outer or local tracks are spread enough to make room for the station platforms between the local and express tracks, as shown on the plan on our inset sheet. The total divergence of the local track from its regular tangent course is 16 ft. Passengers go under the sidewalk and over the local track to reach the platforms at these stations, as shown in the drawing.

On the Boulevard section, from 59th St. to 181st St., Mr. WORTHEN proposed to excavate by an open cut, except where tunnels or viaducts are necessary. The four tracks would be kept together and placed in the parkway in the center of the street. The local tracks would be roofed over, as shown in the drawing, but an opening 16 ft. wide for the whole length of the line to admit light and air would be left along the center of the tunnel. Stations here would be on the street level, extending across the tunnel, with stairs leading to the platforms, which would be placed between the tracks at both local and express stations along this section.

The other drawings presented by Mr. WORTHEN, which we do not reproduce, show sections for different portions of the line, where the standard section is departed from. Below City Hall he proposed only two tracks, placed on one side of the street, and spread at stations far enough to place the station platform between them. At Thirty-sixth St. the tracks have to be spread to pass around the sheave-pit of the cable railway. He also submitted an outline design for a viaduct across Manhattan Valley with bowstring-truss spans.

THE PARSONS DOUBLE-DECK SYSTEM.

The principal features of this system are the disposal of the tracks on a two-story or double-deck structure, placed just beneath the street surface, and the placing of the pipes and wires in a subway chamber beneath the tracks. The platform for local trains is only 10 ft. 10 ins. below the sidewalk level, or about 6 ft. 6 ins. less depth than in the Worthen plan. The total depth of the whole structure is 24 ft. 8 ins., or about 4 ft. 8 ins. more than that contemplated for the Worthen system.

Mr. PARSONS proposed constructing this system by excavating from the surface, leaving however at least one-quarter of the width of the street to destroy a good sized area of paving and dig up several cubic yards of foul smelling earth every time a steam, gas, or water pipe starts a leak. Upon the inset sheet three sections are given, showing the existing pipes, &c., beneath the surface at three different places on Broadway. Below them is shown the arrangement of the same pipes in the proposed subway, and the ease of access and room for extension of the system are readily perceived. The arrangements for entering this subway chamber without interfering with the railway lines were carefully worked out by Mr. PARSONS, and were fully described in his report, which should be studied in connection with his drawings for a thorough understanding of the plans presented.

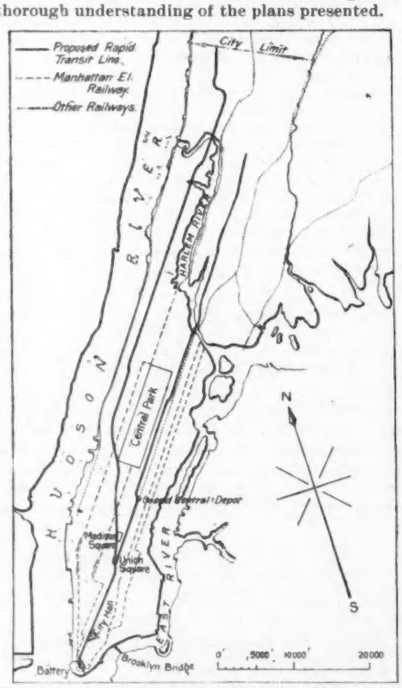


Fig. 1. Map of New York City Showing Route of Proposed Rapid Transit Railway.

In connection with the matter of equipment, Mr. PARSONS, in conjunction with Mr. D. L. BARNES, prepared a design for a car for the road, which is shown in the accompanying cut. The end aimed at was to secure the greatest space in the car body with the least height above the rail.

GENERAL PLAN OF CONSTRUCTION ADOPTED BY THE RAPID TRANSIT COMMISSION.

We publish in full herewith (excepting a few paragraphs of only legal importance and the formal statement of the route) the report submitted to the Common Council by the Rapid Transit Commission on Oct. 21. The report was accompanied by 52 large drawings, most of which, however, consisted merely of large scale maps and profiles locating the line of the proposed road as determined by the Commission's engineers.

To make clear to our readers the general route of the proposed lines we have plotted them down on the accompanying small scale map, Fig. 1. The total length of the proposed railway, as there shown, is a little over 25 miles. Trains will be turned at Battery Park, the southern terminus, and at City Hall Park, about three-quarters of a mile north, by loop lines, the sharpest curves on which are of 150 ft. radius. Figs. 2 and 3 show these loop lines. The loop at the Battery is double track, an arrangement probably adopted to prevent the blocking of traffic by any obstruction or accident on one of the tracks. From a point just south of the Post Office to Bowling Green, three tracks are provided for. We believe the intention is to use the central track as a storage track for trains, on which a considerable number of extra trains will be laid up at the close of the rush of downtown traffic in the morning and will be started out during the rush hours for uptown traffic at night. In this way the train service will be, to some extent, proportioned to the traffic, and the expense of running so many empty trains in one direction when traffic is heavy in the opposite direction will be partially avoided. The loop line at City Hall Park will afford direct connection with the Brooklyn Bridge, and will perhaps furnish facilities for the prompt dispatch and receipt of mails at the Post Office.

The junction of the East and West Side lines at Union Square, shown in Fig. 4, has been arranged to avoid grade crossings by trains going in opposite directions; and 2% grades have been used in raising and depressing the tracks.

The remaining drawings show standard sections adopted for different portions of the road. Fig. 5 is a section of the three track line below City Hall, taken at a station. Fig. 6 is a standard section of the four track line above City Hall on Broadway and on Madison Ave. The arrangement of tracks and platforms at stations where both local and express trains stop is very well shown by the perspective view, Fig. 7. The local tracks are diverged at these stations, a plan view being substantially the same as the plan view of the station in Mr. WORTHEN'S designs, shown in our inset sheet.

On the Boulevard the standard construction adopted is quite different from that on other portions of the road. Here the pipes and sewers are under the sidewalk, and the roof of the tunnel is therefore raised to within about 2 ft. of the street surface. Instead of locating the tunnel beneath the parkway in the center of the street, as proposed by Mr. WORTHEN, a double track tunnel is placed on each side of and adjoining the parkway.

With the exception of this and a few changes in details, the Commission has adhered pretty closely to the plans proposed by Mr. WORTHEN. One noticeable change is the substitution of three columns to support the transverse beams which sustain the roof of the tunnel on the four track sections instead of the single column at the center, shown in Mr. WORTHEN'S plans. If the cross-beam is made with a sufficient margin of strength to support the material above it in case anyone of the supporting columns is knocked out by a derailment or other accident, this may be a wise change.

The following is the report of the Rapid Transit Commission to the City Council:

PRELIMINARY WORK.

The board in entering upon the duties imposed upon it by the statutes of this State determined at the outset that it must lay the foundation for such a broad and

comprehensive system of rapid transit as would meet the needs of the city at present and be capable of expansion in the future; that both express and way service should be provided, and that the construction should be effected with a minimum of street obstruction.

The commission caused careful and accurate borings to be made on Whitehall St. and Broadway, at every cross street from Front St. to Thirty-third St. The results are shown on Exhibit 1 [See ENG. NEWS, July 18, 1891], and are indicated generally by the following table, giving the depths of the rock below the street surface at the streets named:

	Ft.		Ft.
Front St.	20	Leonard St.	95
Pearl St.	16	Walker St.	107
Stone St.	21	Canal St.	87
Beaver St.	34	Broome St.	47
Rector St.	63	Houston St.	105
Fulton St.	83	Washington Pl.	34
Park Pl.	112	Clinton Pl	65
Chambers St.	100	Fourteenth St.	13
Duane St.	163	Thirty-third St.	4

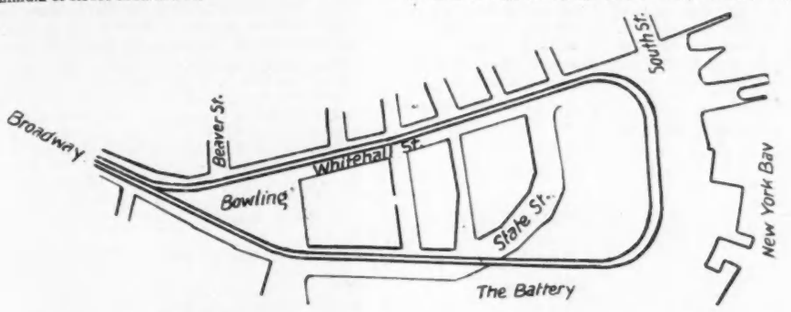


FIG. 2. MAP OF DOUBLE TRACK LOOP AT THE BATTERY (SOUTHERN TERMINAL.

The board, by advertisement, invited the submission to it at public meetings of suggestions as to routes, plans and manner of construction. These public meetings were largely attended, and plans submitted in great variety and number, which were carefully examined and considered. The commissioners made personal investigation as to the exact needs of the city in its several localities. Statistics were gathered as to population, present lines of transit and the number and destination of passengers carried on such lines. The members of the board personally went over all routes suggested, as well as over others laid out by the board, including the ones now presented for your consideration.

It was appreciated that any system devised with a view to permanency and the capacity requisite for the future would be very costly, and the route therefore should be along main arteries of travel, in order to give relief where most needed and to command the necessary traffic to make the line remunerative. Well-known statistics established the fact that the existing north and south lines of transit nearest the center of the city absorbed the greater traffic, and that the relative pressure upon them was substantially in proportion to their proximity to Broadway. These considerations demanded the location of the lower part of the proposed route on or near that thoroughfare. Such a route could be continued by diverging lines above Fourteenth St. on the east and west sides of the city respectively, reaching the largest centers of population, now least provided with transit facilities, and avoiding the necessity of more than one route below Fourteenth St.

GENERAL PLAN OF THE STRUCTURE.

With this much determined, the two governing questions remaining were the general plan of the structure and the motive power to be used. Appreciating that a viaduct of masonry would be the most desirable means of transit, the commission considered many plans for such a route. An elevated structure on Broadway below Thirty-third St. was prohibited by the statute. A viaduct of masonry was manifestly impossible on any adjacent street. A viaduct through the blocks in the lower part of the city, the commission believed, after searching investigation, to be too costly, and subject to too many delays in the acquisition of property rights, to be within reasonable hope of attainment. It was, therefore, unavoidable that rapid transit in the lower part of the city must be secured by an underground structure.

The location of such an underground structure through blocks near the surface was considered. This system had some advantages. The stations could be conveniently placed and the amount of excavation would be reduced, which is a material item where the earth has to be removed through crowded streets. Many of the objections, however, to the viaduct system, as to cost and long delay in the acquisition of vast amounts of real estates, applied with almost equal force to this plan, and the commission considered its adoption unwise.

It would extend this report beyond proper limits to lay before you all the reasons which influenced the selection of the line under Broadway. The determination to adopt such a line was communicated to the public in the resolutions of May 27, 1891, and was generally approved. A line under Broadway being decided upon, the question was narrowed to the character of the structure and its distance below the surface; whether it should be deep or shallow; whether, in providing for the four tracks necessary, the entire width of the street or only a portion should be used, and whether the surface of the street and existing pipes should be again disturbed.

DEEP ROCK TUNNELS AND TUNNELS NEAR THE SURFACE.

The impression prevailed to some extent that a tunnel could be driven under Broadway entirely through rock within a reasonable distance of the surface, thereby obtaining a stable roof and thus avoiding many difficulties in construction.

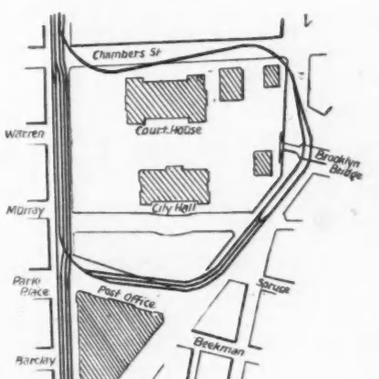


Fig. 3. Map of Loop Around City Hall Park.

Exhibit 1 also shows the material overlying the rock to be sand of different degrees of coarseness. The difficulties of final decision related especially to that portion of Broadway covered by these test borings. North of Thirty third St. the width of the street was greater, and the rock formation was at such a height as to admit of excavation in almost any desired form without endangering foundations. This was also the case with the east-side line above Fourteenth St. finally adopted. These borings conclusively disposed of the idea of a continuous rock roof for a tunnel, except at such depth or with such grades as to be almost, if not quite, prohibitory.

BEST DEPTH FOR A TUNNEL IN THE SAND.

It followed, then, that a tunnel for a considerable portion of its length—and that probably under the portion of Broadway where questions of property rights would present the greatest difficulties—must be driven through sand. The question was whether this could be best accomplished near the surface or at a considerable distance below; and if the latter, what that distance should be. A decision depended upon a variety of complex considerations. Some related to the convenience and cost of construction; others, and the more important ones, to operation when completed. The cost of tunneling at such depth as to avoid all question of property rights might be cheaper, but the extent of the cheapening would depend upon the depth and might be easily exaggerated. Much would depend upon the number and depths of shafts used. The mere cost of excavating below ground would be but a small proportion of the whole when it is considered that all the excavated material for a commodious four track structure with ample station and platform facilities must be raised to the surface through shafts opening on or near crowded streets.

The question also arose as to what depth would secure immunity from damages when the material to be excavated was sand, liable to be wet and to run, with this liability increasing with the depth, and when the pressure from above was that of Broadway's heaviest buildings. To this nothing but trial and experience could give an answer.

The difficulties of ventilation and drainage increase with every foot of depth. A deep tunnel would require elevators as a means of access, and stairways would be necessary in addition, which, except for emergencies, would be practically useless, and to properly provide for emergencies must be broad and costly. Modern and improved elevators in sufficient numbers would doubtless provide for the regular volume of traffic at ordinary stations, but they are not believed to be adapted for large crowds, such as must frequently gather on a line of transit under Broadway. Stairways 100 ft. more or less in vertical height would be of no avail as sources of relief for crowds moving upward, and would be extremely dangerous for crowds moving downward. Moreover, it is not believed that a deep subterranean line of transit, with elevators, would attract short-trip passengers, and the short-trip business is absolutely essential for the success of any line, the cost of which at all approximates that of a four-track tunnel in New York City.

It is admitted by the strongest advocates of underground transit that, other things being equal, the nearer the station platforms are to the surface, the more attractive the line. Conceding, however, that there are some advantages in deep tunneling for lower Broadway, it is seen that they apply entirely during the time of construction and to the first cost of the structure. These, while important, cannot weigh against permanent advantages to be derived in comfort and convenience to the public, facility of operation and the securing of patronage after completion. Ready accessibility by means of short, broad and commodious stairways, supplemented where necessary by elevators, better light and better ventilation at stations, light and air at intermediate points if necessary, and the feeling of greater security on the part of the public with a structure which can be more readily reached in time of accident or other emergency, are too potent to be surrendered to mere temporary difficulties of construction. These and other considerations led to the decision upon the part of the commission to place the underground structure as near the surface of the street as possible, and the engineers of the board were directed to submit two separate plans, one for four tracks on a single level, the other for a double deck tunnel with two tracks upon each deck.

THE ENGINEERS' PLANS.

These plans were prepared, the one providing for four tracks on a level at the minimum distance below the surface to admit of the non-disturbance of existing pipes, conduits and other underground structures, and occupying substantially the entire width of Broadway from curb to curb, but not at such depth as to require excavation below the foundations of the heaviest and most costly structures abutting on the street. This, it was believed, would eliminate to a large degree the difficulties to be encountered in protecting abutting property during construction. This plan also provided for carrying on the work of excavation without disturbance of the street surface, except for short distances at points of exceptional difficulty.

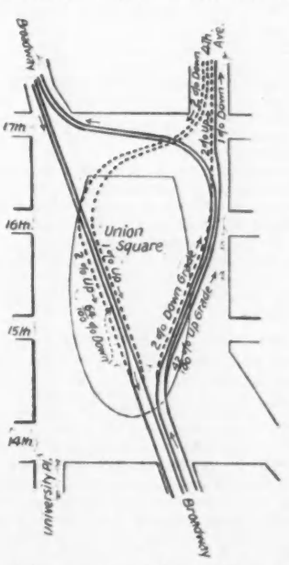


Fig. 4. Map of Junction of East and West Side Lines at Union Square.

The other plan of double deck tunnel would occupy less width of the street, and presented the advantage of the removal and replacement in galleries of the pipes and

other existing underground structures. A disturbance of the street surface would be unavoidable in this case, but a great and permanent benefit would be derived from the fact that such disturbance would not be repeated in the future for any cause except the relaying of the pavement, as the pipes in galleries would be accessible at all times for purposes of repair. The excavation required by this plan was about 4 ft. more in depth than by the other. The length of stairway to the local stations would be less, but to the express stations greater than in the other plan.

These plans, when matured, were submitted separately for separate reports to four distinguished consulting engineers, to wit, Messrs. OCTAVE CHANUTE, of Chicago; JOSEPH M. WILSON, of Philadelphia; THEODORE COOPER, of New York, and JOHN BOGART, State Engineer of New York, with instructions that they were submitted not only for approval or disapproval, but for such general discussion and such suggestions as to alterations and additions as might in their judgment be regarded as necessary or desirable to accomplish in the best manner possible the objects sought to be obtained upon the routes and under the general plans outlined in the resolutions of this commission of May 27 and July 22. [See ENG. NEWS, June 6 and July 25.] The engineers of the commission were instructed to render such assistance and to give such information as the consulting engineers might desire, and to give them access to all records of the commission and all plans and suggestions which had been placed before the board by any person.

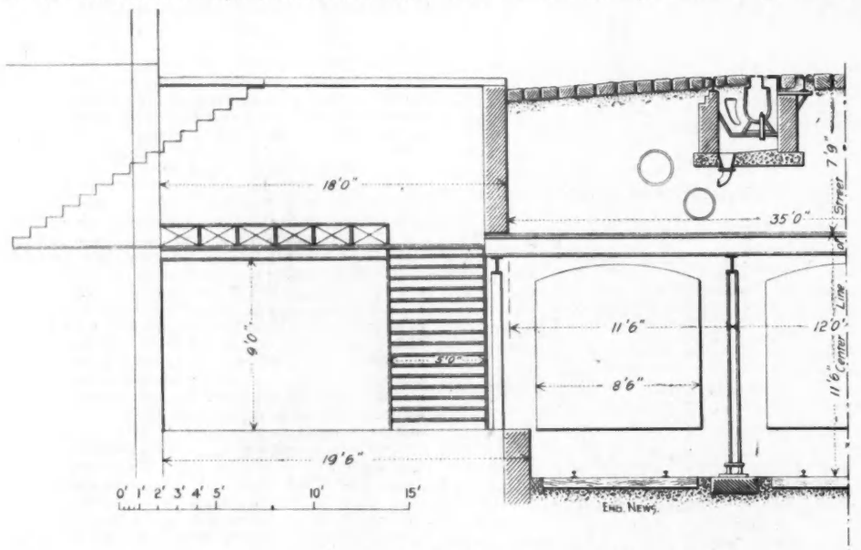


FIG. 5. STANDARD SECTION OF STATION ON BROADWAY BELOW CITY HALL.

In accordance with these instructions full and elaborate reports were received from each of the consulting engineers, copies of which are submitted herewith [See ENG. NEWS, Oct. 10 and 17.] The surveys which were essential to the exact location of the line in the upper portion of the island and the annexed district were completed during the present month. All the necessary information for the final conclusion was thus in the hands of the commission.

REASONS FOR REJECTING THE DOUBLE DECK PLAN.

While the double deck plan provided for subways or galleries for the pipes and other underground structures, and the Rapid Transit act authorized the board to make such provision, yet the board felt that the intent of the act was that such power should be exercised only when necessary for the proper construction of any proposed railway. The adoption of such plan would not only again require the disturbance of Broadway, but might expose the railway and passengers to great annoyance, if not serious danger, from escaping gas and steam; it was open also to the objection of greater noise and possibly inferior ventilation.

The double deck plan moreover burdened the enterprise with the heavy additional expense of pipe galleries and removal of pipes. Another and most serious question which the commission was obliged to consider was facility of movement beeween the different tracks in emergencies causing congestion and delay. No system of rapid transit would be complete that did not provide on its main trunk line at numerous points for the movement of trains from either track to any other, and the transfer of passengers from disabled trains, if need be, at any point between stations. This in the double deck plan could be but partially accomplished, while with four tracks on one level the entire blockade of the system would be almost an impossibility. So important is this consideration that the commission would be loth to recommend any plan wanting in this feature. It would have been regarded as essential even had the commission adopted a plan for a tunnel at greater depth than the one now reported.

The commission, after weighing carefully all these considerations, together with the recommendations of its own engineers and of the consulting engineers and the various suggestions presented to it, thereupon determined by unanimous vote, on Oct. 19, 1891, that the route or routes and general plan of construction of a rapid transit railway for the conveyance and transportation of persons and property should be established in this city as follows.

Here follows a detailed description of the routes which we need not repeat here. In general the lines are to extend from the Battery via Broadway, the Boulevard and Eleventh Ave. to Spuyten Duyvil Creek, and thence continuing in about the same general direction to the city limits. The East Side line diverges at Fourteenth St., and goes underneath Park Ave. to the Grand Central Station, thence via Madison Ave. to Ninety-sixth St., thence parallel with Madison Ave., at a distance of 175 ft. to the east to the Harlem River. After crossing the river the line runs parallel with Jerome Ave., and one or two blocks to the east to a terminus for the present opposite Jerome Park. The map, Fig. 1, shows the location of the lines.

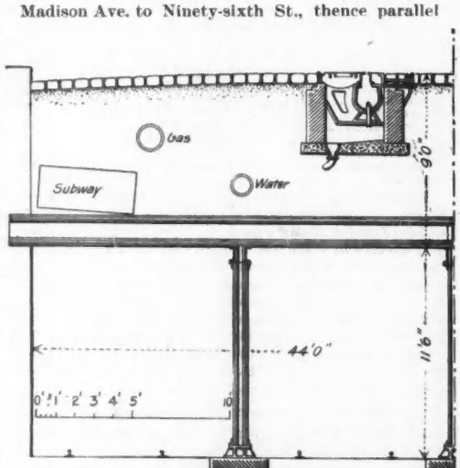


Fig. 6. Standard Section Between Stations on Broadway Above City Hall and Madison Ave.

On the West Side line there will be viaducts from 121st St. to 134th St.; from 156th St. to 159th St.; from 190th St. to King's Bridge Road, and at various points as required north of the Harlem River. There will also be one tunnel 860.6 ft. in length, and another 350 ft. in length.

On the East Side line there will be viaducts from 98th St. to 134th St., and at various points north of the Harlem as required.

Loop lines are provided at the Battery, City Hall Park and Union Square. The report continues as follows:

GENERAL PLAN OF CONSTRUCTION.

The general plan of construction of the loop under Battery Park, State and Whitehall Sts. shall be double track; from the Morris St. junction to near Vesey St. shall be three parallel tracks on the same level, with suitable switches and connections between them; from Vesey St. to 190th St. on the West Side line shall be four parallel tracks on the same level; and thence across the Government ship canal and Spuyten Duyvil Creek to the city limits shall be two parallel tracks on the same level.

On the East Side line from Fourteenth St. to the Harlem River shall be four parallel tracks on the same level, and thence to the city limits shall be two parallel tracks on the same level. The tunnels shall not be less than 11 ft. 6 in. in height in the clear and 11 ft. in width for each track.

Whenever necessary for the proper support of the surface of the street, the roof of the tunnel shall be of iron covering supported by suitable iron columns between each of the tracks, and supporting walls on the outside. The roof of the tunnel shall be as near the surface of the street as the pipes and underground structures now laid therein and the street grades will permit. Viaducts shall be of masonry or iron, or both combined. The Government ship canal and the Harlem River shall be crossed by double track drawbridges not less than 50 ft. in the clear above mean high water mark, with clear spans of not less than 125 ft. between the center piers and bulkhead line. North of the Harlem River the construction shall be by viaduct, depressed structure and tunnel, as the grades of the land upon the proposed routes shall require. The junction of the tracks near Fourteenth St. shall be effected by dividing them around Union Square, raising one pair and depressing the other, so that trains going in opposite directions shall not cross on the same level. All station approaches shall be as far as possible through private property to be acquired for that purpose. Except that on the Boulevard, station approaches may be in the center of the street.

A footway shall be provided the whole length of the line between the center tracks, and refuge niches shall be built in the side walls at proper intervals for the convenience and protection of employés.

The motive power shall be electricity, or some other power not requiring combustion within the tunnel; and the motor or motors shall be capable of a uniform speed for long distances of not less than 40 miles per hour, exclusive of stops.

The manner of construction from South Ferry to about Thirty-fourth St. shall be by underground tunneling without disturbing the surface of the street. In case of necessity the excavations below Beaver St. and in the neighborhood of Canal St. and at such other special points as this commission may, during the progress of the work determine, may be made by excavation from the street surface, and all excavations in Fourth Ave. above Fourteenth St. and in all other streets and avenues above Thirty-fourth St. may be made in the same manner.

LOOPS AND SIDE TRACKS.

The loop at Battery Park is adopted as furnishing the best and most convenient method for the terminal handling of the trains, both way and express. The three tracks between Bowling Green Junction and Vesey St. provide amply for the volume of traffic below the City Hall and avoid encroachment beyond the curb line in Broadway at its narrowest points. The introduction of a loop at City Hall Park by which trains may be stopped, turned and dispatched up town continuously and without switching, and, as shown by the drawings, without grade crossings for trains in opposite directions, furnishes the best means of a second downtown terminus at the most important point and the best means of connecting with the Brooklyn Bridge. At Union Square, as shown in the accompanying drawings, a system of tracks has been devised by which all trains on the Broadway and Madison Ave. line are accommodated at a single station, and all grade crossings between trains in opposite directions are avoided, thus facilitating high speed and eliminating in the best manner possible the dangers and delays incident to such crossings.

At Ninety-sixth Street the contour of the ground necessitates the termination of the tunnel. It therefore became necessary to deflect the line from Madison Ave. and occupy private property thence to the Harlem River, on account of the prohibition in the Rapid Transit act against the use of Madison Ave. for an elevated structure.

The stations on the route selected have not been located for the reason that the board was advised that they constitute part of the detailed plans which the commission are required to complete after the general plan shall have received the approval of your honorable body. Detailed plans and specifications for the construction of the railway, including stations, devices and appurtenances deemed necessary to secure the greatest efficiency, public convenience and safety, will be prepared by the commission in accordance with the provisions of the act if this report is approved.

The commission make no recommendations as to the

method of construction. These matters the commission will deem it wise to leave, so far as permitted by the act, to the judgment of the purchaser, subject always, as the act requires, to the control of this board. The particular shield, if any, to be used in excavating under the streets, the details as to materials and form of walls and other interior surface, should, as far as consistent with the requirements of the act, be subject to his selection. Any attempted determination of the method of construction in advance might narrow the field of possible competition to such an extent as to endanger the success of the enterprise.

MOTIVE POWER.

When the commission decided to adopt an underground route, it also decided that the motive power must be secured without combustion in the tunnel. Much attention has been devoted to the consideration of electricity as a motive power. Consultations have been held with eminent electricians; experiments have been witnssed; electric roads in operation have been examined. While the board is convinced that electricity as a motive power is available for the purposes of the railway recommended by this report, it is not deemed wise at the present time to exclude other forms of power answering the essential conditions of speed and non-combustion in the tunnel, or to attempt to direct the exact method of application of such power as shall finally be adopted.

WILLIAM STEINWAY,
JOHN H. STARIN,
SAMUEL SPENCER,
JOHN H. INMAN,
EUGENE L. BUSHE,
Commissioners.

Iron Ore in the United States.

The last Census Bulletin, No. 113, contains the report of special agent Mr. JOHN BERKINBINE on the iron ore industry in the United States. According to this bulletin the product of 1889 as compared with the previous census was as follows:

	1889.	1879.
Iron ore produced (long tons)	14,518,041	7,120,362
Valued at	$33,351,978	$23,156 957
Average per ton	$2.30	$3.25

The four leading states, out of 26 states and territories producing iron ore, were:

Michigan	5,856,169	long tons.
Alabama	1,570,319	" "
Pennsylvania	1,560,234	" "
New York	1,247,537	" "
Total = 70.49% or	10,234,259	" "

The number of employees engaged in mining iron ore was 37,707 and they received in wages $13,880,-108. The capital invested was $109,766,199, distributed as follows: Land, $78,474,881; buildings, fixtures, etc., $7,673,520; tools, implements, &c., $8.-045,645; cash and stock on hand, $15,572,253.

The stock on hand at the commencement of the census year was 1,966,824 tons, and at the end of the year, 2,256,973 tons, an increase of nearly 15%. The average price of iron ore at the mines for the several states is as follows: Michigan, $2.70 per ton; Alabama, $0.90; Pennsylvania, $1.96; New York, $2.49 per long ton. In 1889, 685 iron mines were producing ore. The difference in price at the mines is regulated by the character of the workings, underground or open, and by the relative richness or leanness of the ores. This is illustrated by the fact that ore from the Lake Superior region averages $2.66 per ton, while the ore from Alabama, Tennessee, Virginia and West Virginia averages $1.20 per ton, and is usually converted near the mines.

In comparing outputs of individual mines of 50,000 tons production each per year with the tenth census we find as follows:

	1889.	Tenth Census.
Number of mines compared	65	19
Ore—Red hematite	46	10
Magnetite	9	9
Brown hematite	8	....
Carbonate ore	2	....
Total product mines compared	10,391,490	2,197,183
Per cent. of total product	71.58	30.86
Value of product of mines compared	$24,340,611	$8,222,640
Per cent. of total value	72.98	35.51

In 1880 the largest output of any one mine was 250,000 tons, and another mine yielded 200,000 tons, and 8 mines produced 100,000 tons each. In 1890, of the 65 mines mentioned above, 31 produced between 50,000 and 100,000 tons each, 17 between 100,-000 and 200,000, 11 between 200,000 and 300,000, 2 between 300,000 and 400,000 tons, 2 between 500,000 and 600,000; one produced 760,000 tons and another produced 809,000 tons of ore. These largest producers are in Michigan.

In estimating the average expenditure in labor and wages per long ton of ore, in extracting the ore, the bulletin gives the following figures: The lowest cost is in the States of Alabama, Georgia and North Carolina, where large open workings, systematic machinery and soft ores reduce this cost to 69 to 71 cts. per ton. In Pennsylvania one-half of the ore comes from the Cornwall ore hills, where its accessibility and softness makes the average cost of extraction for the entire State 75 cts. per ton. The hard Lake Superior ores cost $1.19 per ton for extraction. In Colorado, Idaho and Montana the higher rates of wages and smaller output bring this cost up to $2.48 and $2.21 per long ton. The average total cost of mining iron ore for all the States and Territories in 1889 was $1.71 per long ton, as compared with $2.21 per long ton in 1880—a decrease in cost of 22.62%. This is accounted for chiefly by labor-saving devices and improved facilities for handling the product of the mines.

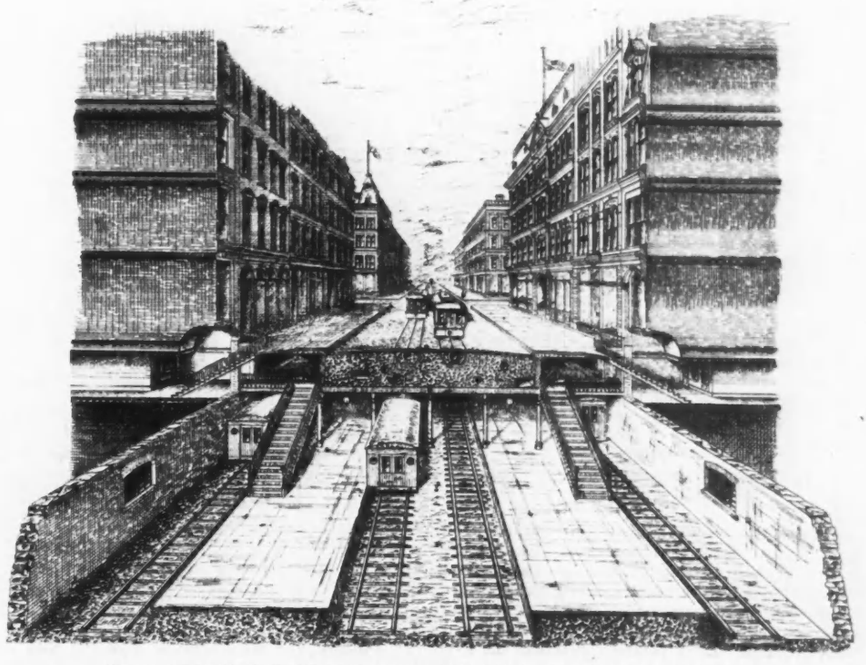


FIG. 7 PROSPECTIVE VIEW OF LOCAL AND EXPRESS STATION ON BROADWAY.

In 1880 the largest output of any one mine was 250,000 tons, and another mine yielded 200,000 tons, and 8 mines produced 100,000 tons each. In 1890, of the 65 mines mentioned above, 31 produced between 50,000 and 100,000 tons each, 17 between 100,-000 and 200,000, 11 between 200,000 and 300,000, 2 between 300,000 and 400,000 tons, 2 between 500,000 and 600,000; one produced 760,000 tons and another produced 809,000 tons of ore. These largest producers are in Michigan.

The total importation of iron ore into the United States, in 1889, was 853,573 tons, valued at $1,852,392. Of this quantity 298,568 tons came from Spain and 243,255 tons from Cuba. French Africa, Italy and England sent us 97,583, 87,410, and 54,496 tons respectively.

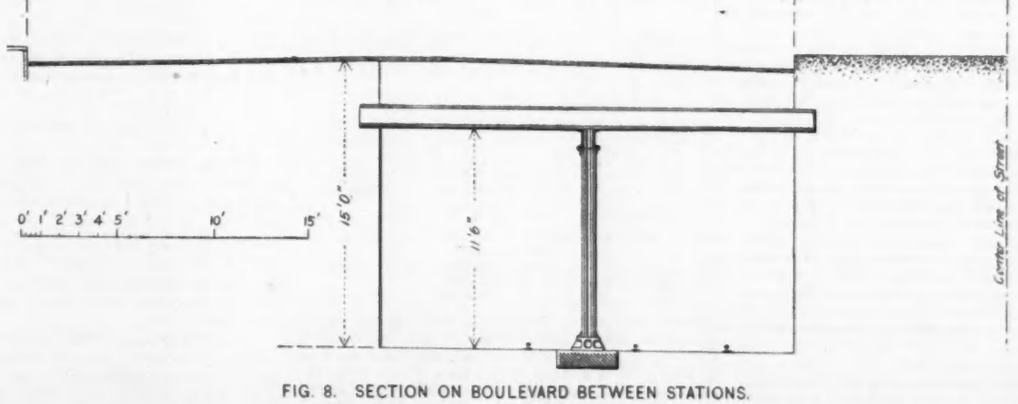


FIG. 8. SECTION ON BOULEVARD BETWEEN STATIONS.

As intimated above, the reduction in the price of iron ore is greatly due to increased facilities for transporting and handling the product. What this means is best appreciated by reference to the shipping docks for the ore from the Lake Superior region. The Duluth, South Shore & Atlantic Ry. Co., at Marquette, Mich., has 4 docks of a combined capacity of 74,000 tons, with a height above water of from 35 ft. to 47½ ft. At L'Anse, Mich., there is a dock of 8,000 tons capacity; at St. Ignace, Mich., is a dock of 10,000 tons capacity. At Escanaba, Mich., the Chi-

cago & Northwestern Ry. Co. has 4 double docks of 95,000 tons combined capacity. These docks cost $922,000, and the 3,300 cars of 7 to 10 tons capacity and 1,800 20-ton cars cost $1,368,000 more. At Two Harbors, Minn., the Duluth & Iron Range Ry. Co. has 2 double docks of 40,000 tons capacity in all. These docks cost $800,000, and 750 cars cost $431,250 more. These cars are double-hopper 8-wheel cars of 50,000 lbs. each load. At Ashland, Minn., the Wisconsin Central and the Milwaukee, Lake Shore & Western Ry. Co.'s have iron ore docks. The first named road has one dock of 28,250 tons capacity, which cost $256,000, and 78 cars of 50,000 lbs. each, and 90 drop-bottom gondola cars of 40,000 lbs. capacity each, cost $388,800 more. The second road has two docks of a combined capacity of 50,000 tons. These docks cost $483,000; and 800 cars of 45,000 lbs. and 50 cars of 60,000 lbs. cost $330,000 more.

In addition to these shipping docks are the fleet of specially constructed ore-vessels and the wonderful receiving ore-docks on Lake Erie, at Cleveland, Buffalo, Ashtabula, Fairport, &c. The largest of these docks, at Fairport, O., has a frontage of one mile, with room for stocking extending 180 to 350 ft. in width. At Cleveland, O., Mr. ALEX F. BROWN has made a special feature of manufacturing machinery for handling ore. The cost of shoveling ore into buckets in the hold of vessels varies from 10 to 15 cts. per long ton; while with the improved dumping apparatus this ore can be lifted, carried back 350 ft. and dumped at a total cost of from ¾ to 1½ cts. per ton. With 21 men in the hold, 2,000 tons of iron ore have been stocked in 17 hours. Other cases are noted where 28 men have thus handled 2,200 long tons in 15 hours, and 18 men 2,100 tons in 17 hours.

The Relative Economy of Electric, Cable and Horse Railways.

At the street railway convention held this week in Pittsburg, Mr. J. S. BADGER, of the staff of the Edison General Electric Co., presented a paper on "Electricity the Most Economical Power for Street Railways," which gave some interesting and late statistics, and seems to have been carefully and fairly prepared. After pointing out that the two items of first cost and operating cost per car mile furnished the fairest and most useful basis of comparison and calling attention to the important effect of differences in price of coal and labor, and in intelligent care of the plant, the paper continues:

FIRST COST.

Direct information concerning cable roads has not been obtainable. The figures we cite are those given by the Census Department, and do not seem to have been questioned by any authority. The data concerning horse roads, being taken from sworn reports to the Massachusetts Board of Railroad Commissioners, can also be relied upon. The figures given concerning investment in electric roads have come from official sources, and are confirmed by private information. These are, however, excessive. Most of the roads mentioned were formerly horse roads, and to the original investment has been added the cost of change of motive power; and in almost every case, the amount now charged to permanent investment is far in excess of what it would cost to renew the entire power plant, track and equipment.

An attempt has been made to show that electric roads cost nearly as much as cable roads for equal class of construction. How much a company might, for purposes of its own, or through mistaken ideas, see fit to invest, it is not necessary here to discuss; but as to how much is necessary for first class construction, there is little question. One of the foremost roads, with an equipment first class in every respect, has a permanent investment, including paving, almost exactly that given as the average in Table I.

Estimates upon track construction differ greatly, but the limit of profitable investment is not likely to exceed $10,000 per mile; while as fine and substantial a roadbed as electric car ever ran over was built at a cost, exclusive of paving, of about $5,000 per mile.

The overhead structure need not cost to exceed $2,500 to $3,000 per mile of single track for best wood poles, or $3,500 to $5,000 for iron poles. For double track, iron poles, it would vary from $4,500 to $6,500 per mile, center pole construction being the cheaper and in many other respects preferable where it can be adopted; $3,000 to $3,500 per car is a liberal estimate for 16-ft. to 20-ft. cars, fully equipped, and the average is about two cars per mile of road.

An allowance of 15 to 20 HP. per car, at $80 to $100 per HP. for station equipment, including steam plant but not real estate or buildings, is very liberal.

Thus we have, as an extremely liberal estimate, $26,000 per mile, exclusive of real estate, buildings and paving, for a road suitable for the heaviest metropolitan traffic, and it is a fact that a good and satisfactory road can be built and equipped for $20,000 per mile.

As records of actual experience, a careful examination of the statistics presented is invited, and especially of those relating to electric railways. The greater part of these has been obtained by personal visits to the roads reported.

COMPARISON OF INVESTMENT AND OPERATING EXPENSES.

TABLE I.

	Total investment real estate road and equipment. Per mile of street length.	Total investment real estate road and equipment. Per mile of track length.	Car miles run per annum, per street length.	Passengers carried annually per mile of street length.	Passengers carried per car mile run.
22 Electric roads*	$38,500	$27,780	76,158	237,038	3.10
45 Horse roads†...	33,406	31,693	43,945	251,815	5.81
10 Cable roads‡ ..	350,325	184,275	309,395	1,355,965	4.38

TABLE II.

	Operating expenses per car mile run.	Interest charge per car mile at 6% on total investment.	Total of operating expenses and interest, per car mile.	Cost per passenger carried, interest excluded.	Cost per passenger carried, interest included.
	Cts.	Cts.	Cts.	Cts.	Cts.
Electric roads*....	11.02	3.03	14.05	3.55	4.53
Horse roads†.....	24.32	4.62	28.94	4.18	4.98
Cable roads‡.....	14.12	6.97	20.91	3.22	4.77

TABLE III.

	Ratio of investment per mile of street length.	Ratio of car miles run annually per mile of street length.	Ratio of cost of op'ration per car mile, interest included.	Proportion'l traffic that must be done, per mile of str't occupied, to pay operating expenses and 6% on the investment.
Electric roads*	1.152	1.757	.485	.852
Horse roads†..	1.000	1.000	1.000	1.000
Cable roads‡...	10.486	7.138	.726	5.182

* Car miles run per annum, 14,013,187; passengers carried per annum, 43,614,972; street length, 184 miles; track length, 255 miles.
† All the roads in Massachusetts operated exclusively by horses for 1885-90. Average for six years.
‡ From Census Bulletin No. 55.

TABLE IV.—SEVEN REPRESENTATIVE ROADS, OPERATED ENTIRELY BY ELECTRICITY.

Road.	Length. Of all tracks.	Length. Of road.	Pass. carried annually per mile of road.	No. of cars in daily oper'n.	Aver. daily milage per car.	Aver. No. pass. daily per car.	Pass. carried per car mile.	Operat. expen. per car mile.	Operat. expen. per car per day.	Cost per pass. carried.
1	51.0	35.0	*162,857	50	100	323	3.13	12.29	12.29	3.93
2	40.0	19.5	487,582	140	91	188	2.06	7.80	7.10	3.79
3	16.0	19.0	199,000	16	125	343	2.75	8.43	10.54	3.07
4	8.5	5.0	*460,000	20	83	318	3.82	11.82	9.80	3.09
5	15.5	14.0	167,511	18	106	357	3.35	11.00	11.70	3.28
6	28.0	23.5	286,852	31	*108	597	5.51	12.74	13.76	2.31
7	3.8	2.8	200,000	5	92	307	3.33	8.49	7.81	2.55
	162.8	109.8		280				9.83		3.28

* Estimated.

Total annual car mileage, 9,862,000. Total number of passengers carried annually, 29,144,000.

Table I. shows that, taking street length as the unit of comparison, in the cases of the roads under consideration the total permanent investment of the electric roads is only 15% more than that of the horse roads, while the cable roads cost more than nine times as much as the electric roads. Table II. shows operating and interest expenses per car mile and per passenger carried for each of the three systems.

OPERATING EXPENSES.

Average of 22 trolley roads. Length varying from 3 to 51 miles; cars in daily operation, 3 to 140; daily mileage per car, 80 to 150; average daily mileage per car, 110.

Cost of coal varies from $1.00 per ton for slack, to $3.00 for "run of mine," and $3.80 for lump. Wages of conductors and motormen vary from 10 to 20 cts. per hour. Consumption of coal varies from 4.3 lbs. of slack per car mile to 12.2 lbs. R. O. M. per car mile.

The station output varies from 3.7 E. HP. to 8.4 E. HP. per car in operation, for roads equipped with 16-ft. cars and Edison motors. In the latter case the road had many heavy grades and sharp curves. One road, equipped with 30-ft. double truck cars (weight complete about 10 tons), 6 Edison and 14 Short double 15 HP. equipments, traffic medium and grades moderate, required an average of 10.7 E. HP. per car in operation.

The best station performance is 1 E. HP. for every 5 lbs. of slack or 4 lbs. of nut consumed; and evaporation of 7½ lbs. of water per lb. of slack consumed. Return tubular boilers, Murphy furnaces, Armington & Sims high speed, single cylinder, non-condensing engines and Edison generators are in use.

TABLE V.

	Expenses per car mile. (Cents.) H'g'st.	L'w'st.	Av.
Maintenance of roadbed and track.....	1.86	.10	.54
Maintenance of line.....	.95	.01	.12
Maintenance of power plant, including repairs on engines, dynamos, buildings, &c	.86	.05	.36
Cost of power, including fuel, wages of engineers, firemen, dynamo tenders, oil, waste, water and other supplies.	4.95	.48	1.96
Repairs on cars and motors.....	5.24	.59	1.80
Transportation expenses, including wages of conductors, motormen, starters and switchmen, removal of snow and ice, accidents to persons and property, &c ..	9.47	2.74	4.98
General expenses, including salaries of officers and clerks, office expenses, advertising, printing, legal expenses, insurance, &c.....	2.95	.79	1.26
Total.....	*29.99	*7.80	11.02

* Respectively the highest and lowest total for any one road.

DETAILED DISTRIBUTION OF OPERATING EXPENSES.

For roads of 10 or 15 miles and upward, operating twenty or more cars per day, averaging 105 to 110 miles each, grades moderate, a careful distribution of expenses, based upon the experience of the best roads, will *average* about as follows:

		Expenses per car mile (cents).
Maintenance of roadbed and track		.54
Maintenance of line		.12
Maintenance of power plant:		
Repairs on engines and boilers.....	.180	
Repairs on dynamos	.101	
Miscellaneous repairs.....	.078	.36
Cost of power:		
Fuel.....	.868	
Wages of engineers and firemen	.653	
Wages of dynamo tenders, &c	.220	
Oil, waste, water and other supplies.....	.218	1.96
Maintenance of rolling stock:		
Repairs on motors (ex. gearing).....	.695	
Repairs on gearing and trolleys.....	.594	
Repairs on car bodies and trucks	.512	1.80
Transportation expenses:		
Wages of conductors and motor men.....	4.262	
Wages of starters, switchmen, track sweepers, &c.....	.268	
Cleaning and inspecting cars.....	.238	
Oil, waste and other supplies.....	.083	
Accidents to persons and property.....	.061	
Miscellaneous.....	.068	4.98
General expenses:		
Salaries of officers and clerks.....	.743	
Office expenses.....	.138	
Advertising and printing.....	.061	
Legal expenses.....	.068	
Insurance.....	.161	
Miscellaneous.....	.094	1.26
Total.....		11.02

The paper closes with detail tables for seven roads shown in Table IV., which contain many interesting data for which we can hardly spare space.

Road Machine Contest at Mexico, Mo.

The road machine contest held at Mexico, Mo., under the auspices of the State Board of Agriculture was a decided success; nearly every county in the state being represented by one or more delegates. Gov. D. R. FRANCIS was present two days and favored the meeting with one of his characteristic forcible addresses, in which he gave assurance that he was heartily in accord with the movement for better roads.

All the machines that contested did excellent work. The contest was not arranged with the expection of demonstrating the great superiority of any one machine, but more especially to advertise the merits of all and thereby call the attention of the road makers of the West to the great saving of time and money, and the resulting improvement in the condition of our roads by their general use.

The points to be considered in the contest were divided into two classes to be passed upon by seperate committees. First a mechanical expert committee who should pass upon the points covered in score card "A" and a practical roadmakers' committee who should pass upon those points covered in score card "B."

In selecting the members of these committees the Board of Agriculture tried to select men whose

position in the scientific and business world would insure confidence in their verdicts.

The judges to pass upon points in score card "A" were: M. L. HOLMAN, C. E., Water Commissioner, St. Louis, Mo.; GEO. BURNET, C. E., President of the Board of Public Improvements, St. Louis, Mo., and HIRAM PHILLIPS, C. E., of the Engineering Department State University, Columbia, Mo.

The committee to pass upon points in score card "B" were composed of the following well-known persons: ALFRED DEVAULT, member legislature from Montgomery County, chairman of committee on roads; W. T. HEARNE, member of the State Board of Agriculture, Independence, Mo., and J. L. ERWIN, Fulton, Mo.

There were 5 firms represented, entering 7 machines, but only 6 contesting, the "Leader" for some reason being withdrawn. The machines, according to their entrance number, name and manufacturer, were: No. 1, "Western Reversible," Western Grader Co., Aurora, Ill.; No. 2, "Light Champion," American Road Machine Co., Kennett Square, Pa.; No. 3, "King," manufactured by the same company as the Light Champion; No. 4, Ft. Wayne Reversible, Fleming Mfg. Co., Ft. Wayne, Ind.; No. 5, The Leader of the Fleming Mfg. Co.; No. 6, The Mt. Pleasant Reversible, Mt. Pleasant Road Grader Co., Mt. Pleasant, Ia.; No. 7, The Austin Reversible, F. C. Austin Mfg. Co., Chicago, Ill.

The contest was a working trial with the exception of the draft, which, owing to the limited time and the intensely hot and dry weather, was omitted, and for the sake of uniformity and so as to compare on a scale of 100, all were graded perfect at 20. The weights of the machines were as follows:

Western Reversible	2,022 lbs
Light Champion	2,220 "
King	2,306 "
Ft. Wayne Reversible	2,132 "
Mt. Pleasant	2,022 "
Austin Reversible	2,259 "

The following score-cards, A and B, give the results of the trial:

SCORE CARD, NO. "A."

Points to be considered in trial of Road Graders, at Mexico, Missouri, Sept. 15-17, 1891, on scale of 10.	No. 1, Western Reversible.	No. 2, Light Champion.	No. 3, King	No. 4, Ft. Wayne.	No. 5, Leader	No. 6, Mt. Pleasant.	No. 7, Austin.
1. General construction	9.	8.0	7.5	8.0	.....	6.	8 7
2. Quality and class of material	9.	9.0	9.0	9	.....	9.	9.0
3. Mechanical proportion of parts	9.	7.0	7.0	9.	.....	5.	9 5
4. Durability	9.	8.5	8.5	9.	.....	8.	8.5
5. Ease of management and adjustment for various kinds of work	9.	8.	8.	9.	.....	6.	9.
6. Acute working angles of blade	9.	8.	7.	10.	.....	7.	9
7. Position of blade to ground and ability to scour	10.	10.	10.	10.	.....	10.	10.
8. Average distance earth is moved, each successive round, from bottom of ditch to center of road	10.	10.	10.	10.	.....	10.	10.
9. Capacity of machine to build a given amount of road in a given length of time	9.6	9.6	9.8	10.	.....	9.3	9.
10. Quickness of action and power applied to blade by lever	9.0	7.	7.5	7.5	.....	6.	9.
11. Ease of transportation and housing	10.0	10.	10.	10.	.....	10.	10.
12. best position for operator to view work of blade and team	9.	6.	7.5	8.5	.....	9.5	9.7
Total	111.6	101.9	101.8	110.0	.....	95.7	111.4
Summary—							
Durability, on scale of 16	14 4	13 6	13.6	14.4	.....	12.8	13.6
Adjustability, on scale of 14	13.	10.3	11 3	12.5	.....	10.1	13.8
Simplicity, on scale of 10.	9.8	9.8	9.0	9.8	.....	9.0	9 4
Total, 40	37.2	34.0	33.9	36.7	.....	31.9	36.8

No. 5, the Leader, was entered, but was not brought on the field.

SCORE CARD, NO. "B."

Points to be considered in trial of Road Graders at Mexico, Missouri, Sept., 15-17, 1891, on scale of 10.	No. 1, Western Reversible.	No. 2, Light Champion	No. 3, King	No. 4, Ft. Wayne Reversible	No. 5, Leader	No. 6, Mt Pleasant.	No. 7. Austin.
1. Ability of machine to do its own plowing	10.	8.	8.	8.	.....	7.3	10.
2. Borrowing from banks outside of wheel	8.6	8.3	8.	7.7	.....	8.	10.
3. Making ditches	10.	8.3	9.	10.	.....	7.7	10.
4. Filling ditches	10.	10.	9 7	10.	.....	10.	10.
5. Moving earth to either right or left, ordinary work	10.	8.	9.3	8.	.....	8.3	10.
6. Moving earth to either right or left, up steep slope	7.7	8.	9.3	7.7	.....	7.7	8.
7. Moving earth straight forward down hill	8.6	8.7	8.7	8.3	.....	10.	8.7
8. Working side hill, borrowing from one side and filling other	9.4	8.	7.7	7.3	.....	8.	9.3
9. Behavior when working gravel or stony hills, hard clay, gumbo, or hard packed roads	10.	8.6	6.3	7.7	.....	6.	9.7
10. Freedom from choking in high grass, weeds, heavy sod or wet ground	9.6	7.	8.3	8.	.....	8.	9.3
11. Freedom from sliding sideways	8.4	7.7	10.	7.7	.....	7 3	8.
12. Widening narrow turnpiked or graded roads	10.	8.	8.7	8.6	.....	8.3	10.
Total	112.3	97 6	103.0	99.0	.....	96.6	113.0
Summary—							
Variety of work, on scale of 10	9.7	9.7	7.7	8.3	.....	8.7	10.
Quantity of work, on scale of 14	13.3	12.	11.7	12.	.....	12.	14.
Quality of work, on scale of 16	16.	13.	14.6	14.	.....	12.	15.
Total	39.	34.7	34.	34.3	.....	32.7	39.0
Draft, on scale of 20	20.	20.	20.	20.	.....	20.	20.

No. 5, the Leader, was entered, but was not brought on the field.

Cost of Traction on Street Railways in England.

The following article is taken from a recent number of *Engineering*, London, and is especially interesting at this time, when so much attention is being paid to various systems of mechanical traction. Some figures of the cost of operation of horse and electric railways in this country were given in our issue of Sept. 26 and others will be found on the preceding page.

Every system of tramway haulage appears to be in use in Birmingham. There are horse cars, electric cars, steam cars and cable cars, all working under the direction of the Birmingham Central Tramway Co A capital opportunity is thus afforded of comparing the various methods of traction, and this is further aided by the explicit manner in which the company's accounts are made out, each department being kept separate, both as regards receipts and expenditures. Of course it is very easy to push conclusions drawn from the accounts too far, for each line runs under its own conditions, and its profits depend not only on its method of working, but also on the available traffic, the gradients and other considerations. Hence, although one system may show more favorably than another in Birmingham, it does not follow that it will give equally good results elsewhere, or even in another part of the same town. Further, the amount of depreciation on each class of haulage plant is not shown in the accounts, the sum of $40,000 being set aside to cover all demands under this head, but not being allocated in various proportions to the different departments. The stud of horses is maintained by renewals, which are charged to the horse account, while wages and materials for repairs are charged against the machinery account. It is probable that the stud is kept up to a fairly constant standard by the renewals, while the machinery, in spite of repairs, will suffer some steady depreciation. At present much of it is nearly new; the cable has only been running two or three years, while the electric cars started July, 1890. The mileages and earnings of the various systems are given in Table No. 1.

TABLE NO. 1.—MILEAGE, PASSENGERS AND EARNINGS.

Department.	Miles run.	Passeng'rs carried.	Balance to rev.
Steam	1,184,401	14,742,827	$115,594
Horse car and omnibus	131,528	1,114,388	16,381
	506,196	2,638,128	
Cable	522,876	5,241,362	70,830
Electric	128,396	1,144,718	15,103

The bulk of the work is done by the locomotives, and next to them comes the cable. The average number of passengers carried and the profits earned per mile run are given in Table No. 2.

TABLE NO. 2.—PASSENGERS, EXPENSES AND PROFITS PER CAR MILE.

Department.	Passengers.	Expenses.	Profit.	Earnings.	Average receipts per passenger.
	No.	Cts.	Cts.	Cts.	Cts.
Steam	12.02	21.98	9 36	31.34	2.60
Horse	5.80	19.58	2 46	22.04	3.80
Cable	10.02	12.66	13 00	24.06	2.56
Electric	8.27	19 80	10.50	30.30	3.66

This table shows that the services ran under very different conditions. The horse cars and omnibuses only secured 5.8 passengers per mile run, and barely made a profit Of the receipts 89% were absorbed in expenses in spite of the fares being high. Probably the omnibuses are accountable for the average fares being nearly 4 cts. The steam cars appear to have the best district, for they obtained twelve passengers per mile, and about 2½ cts. per passenger, the percentage of expenses to gross receipts being 70. It is noticeable that the steam cars earned 0.36 ct. per mile run by displaying advertisements, the horse cars and omnibuses 0.28 ct., the cable cars only 0.16 ct. and the electric cars 0.26 ct. The cable cars secured a very fair amount of passengers, 10.02 per mile, and nearly as good a fare as the steam cars, 2.56 cts. against 2.6 cts. They were, however, run very economically, the expenses being only 12.66 cts. per car mile, or 49% of the gross receipts. Considering that ordinary tramways average from 70 to 80%, this result is very noticeable. The electric cars showed very satisfactory returns, in spite of the comparatively small traffic, 8 27 passengers per car mile; the fares, however, were high, 3 66 cts. per passenger; which means that the passengers rode a considerable distance, thus bringing the earnings to 30.3 cts. per mile, nearly as much as in the case of the steam cars.

When we turn to the details of the working expenses we find why they are so high in the case of the steam cars. Wages and materials cost 3.56 cts. per car mile, as against 0.86 ct. for renewal of the stud for the omnibus

TABLE NO. 3.—ANALYSIS OF WORKING EXPENSES.

Department.	Wages.	Fuel.	Gas and water.	Stores, sundries and repairs.	Car repairs.	Traffic expenses.	Track and buildings.	General charges.	Total.
	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.
Steam	4.12	3.80	.44	4.40	.66	3.36	3.10	2.10	21.98
Horse	4 88	7.44*	.12	2 22†	1.08	2.52	.28	1.04	19.58
Cable	2.92	1.32	.14	2 34	1.66	2.60	.26	1.42	12.66
Electric	5.20	3.32	.14	2 22	3.86	2.68	.28	2.10	19.80

* Forage and boiling.
† Including shoeing, veterinary and renewals.

ELEMENTS OF WEATHER IN THE UNITED STATES, OF MOST INTEREST TO ENGINEERS, FOR THE MONTH OF SEPTEMBER, 1891.

[Furnished to ENGINEERING NEWS by the Department of Agriculture.]

	STATION.	Temperature. (Deg. Fah.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Maxim.	Direction at time of max. velocity.	Precipitation — rain and melted snow. Inches. Total.	Heaviest in 24 hours.	Number of rainy day.
NORTHERN CITIES.	Northfield, Vt.	60.6	85	36	49	7.4	33	S	0.98	0.30	12
	Portland, Me.	62.8	71	55	16	7.0	26	SW	1.94	0.51	9
	New York City	70.1	87	54	33	8.1	28	N	2.12	1.59	9
	Pittsburg, Pa.	69.4	90	46	44	3.9	38	SW	1.90	0.58	7
	Chicago, Ill.	69.0	91	48	43	14.1	40	SW	0.32	0.20	4
	Omaha, Neb.	70.0	91	43	48	8.1	26	S	1.76	1.02	9
	St. Paul, Minn.	65.6	92	39	53	6.8	29	SE	0.58	0.40	6
	Duluth, Minn.	61.6	90	42	48	5.3	35	W	3.31	1.80	9
	Bismarck, N. Dak.	61.8	92	32	60	9.7	40	SE	0.87	0.41	7
	Average	65.7	87.7	43.9	43.8	7.8	32.8	.....	1.53	0.76	8
SOUTHERN CITIES.	Washington City	70.0	90	49	41	4.0	18	NW	3.12	1.62	5
	Louisville, Ky.	71.8	92	51	41	3.8	23	W	1.99	1.09	6
	St. Louis, Mo.	74.0	94	51	43	8.5	45	SW	1.43	0.98	4
	Savannah, Ga.	75.8	89	64	25	5.6	26	NE	2.69	1.14	8
	Leavenworth, Kan.	70.8	92	41	51	5.8	24	S	0.57	0.43	5
	Jacksonville, Fla.	77.6	89	65	24	5.6	26	W	10.83	3.79	11
	Chattanooga, Tenn.	77.2	91	54	37	3.6	17	SE	2.06	1.26	8
	New Orleans, La.	77.9	90	63	27	7.9	48	NE	3.43	2.21	12
	Memphis, Tenn.	74.9	95	53	42	5.1	25	SE	0.59	0.39	2
	Palestine, Tex.*	75.6	92	52	40	4.7	24	E	1.53	0.67	6
	Average	74.6	91.4	54.3	37.1	5.5	27.6	.....	2.82	1.36	7
WESTERN CITIES.	Helena, Mont.*	....	..	..	..	....	..	.....	....	..	..
	Port Angeles, Wash.	53.6	73	38	35	2.6	12	SW	3.65	1.18	14
	San Francisco, Cal.	61.8	86	51	35	9.5	29	W	0.77	0.63	5
	Salt Lake City, Utah	65.0	89	38	51	6.8	38	SW	1.19	0.63	9
	Denver, Col.	64.2	91	37	54	6.6	30	N	0.73	0.24	10
	Yuma, Ariz.	83.4	110	54	56	6.0	35	NW	....	....	0
	Santa Fé, N. Mex.	61.8	82	38	44	7.1	40	NW	4.69	1.42	13
	Average	65.0	88.5	42.7	45.8	6.4	30.7	.....	1.84	0.68	8

* No record.

and horse cars. The fuel account was three times as high as that for the cable cars, and 15 per cent. higher than for the electric cars. The costs for track were also very heavy as compared with the lines worked by cable and electricity. These latter lines are, we believe, much newer; the cable line is, of course, very lightly loaded, but with the electric cars the weight on each axle will not be greatly less than with the locomotives.

We may take it that the expenses in the steam and horse departments fairly represent an average, since they have been in operation for a considerable time, and that there will be neither great increases nor noticeable economies in the future. In the cable department many of the items may be looked upon as permanent. Wages, fuel and water should not increase. The repairs probably will grow rather heavier, as of the 2.34 cts. debited to them as much as 1.76 cts. is put down to materials, probably new cables, and 0.44 cts. to stores and sundries, leaving only 0.14 for wages. Car repairs are already heavy; the repairs of track may be expected to increase very considerably, as at present they are not greater than in the horse department, which is mostly worked by means of omnibuses. The general charge seems also to be low.

As regards the electric department we must remember that it has only been started a year, and that many economies may yet be made. The wages account shows that very considerable attention is required, and that highly paid supervision is necessary. With a larger number of cars this charge would be decreased. The fuel account is, at any rate, less than for the locomotives, and would be much less with a larger installation. The sum of 2.22 cts. for stores, sundries and repairs of machinery is not excessive, but 3.86 cts. for car repairs is certainly very high. We should like to know what part of this is represented by battery plates, and what by new armatures. The sum is made up of $1,745 for wages, and $3,814 for materials. As we have already stated, the car mileage was 138,396, or about the work of six cars, whence it follows that it required the constant services of a mechanic for each pair of working cars. This is another item that ought to be greatly decreased, but it is possible that 2.66 cts. per car mile for materials may be increased on a longer experience of the wear and tear of batteries. This is a point on which it is very difficult to procure full and reliable information.

The general impression left by the figures is adverse to the locomotive, a result most people who have any experience of steam cars will welcome. They are most decided nuisances, and can only be tolerated on the ples that they cheapen the cost of traveling to the public. The horse department is mostly devoted to omnibuses, and does not afford a fair basis of comparison for tramway work. The cable department certainly shows most encouraging results; the system is slowly coming in favor in this country, a long line having been just laid down on Brixton Hill, London. If the electric cars had not to carry their motive power, but could work with an overhead wire as in America, they would probably press the cable very closely, and beat it where the service was not very frequent, and when interest on construction is taken into account. On a fairly level road, however, and when all charges are considered, the horse is likely to hold his own in this country for some time to come.

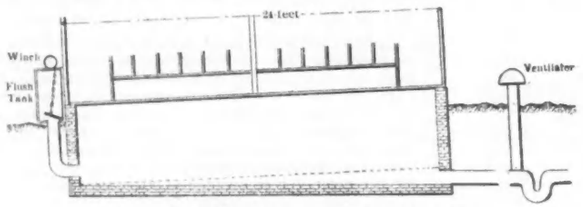


FIG. 1. LONGITUDINAL SECTION OF VAULT.

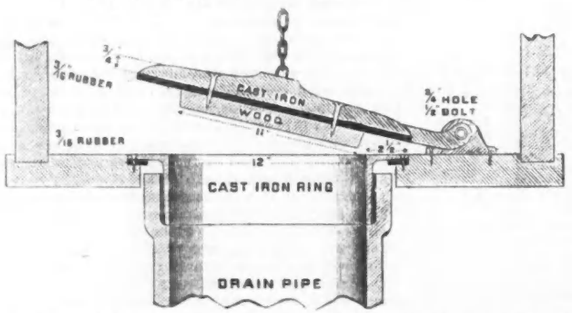


FIG. 2. CROSS SECTION OF VAULT FOR SCHOOL OUTBUILDING.

Flush Vault for School Outbuildings at Lynn, Mass.

The last report of the Committee on Sanitation of the School Committee of Lynn, Mass., contains illustrations and a description of a flush vault used in connection with the schoolhouses of that city. The vault and flushing device are simple in detail, and seem admirably adapted to their purpose, as will be seen by examining the accompanying illustrations.

Figs. 1 and 2 show longitudinal and cross sections of the vault. The vault proper is of hard brick in cement with an invert for the bottom, the latter sloping ½-in. to 1 ft. There are two rows of seats above, back to back, part of the seats on one side being displaced by urinals. The floors of the buildings slope 1 in 12 toward the vault, so that when scrubbed the dirty water may flow through the scuppers, which are 2 × 4 ins., into the vault beneath.

The flush tank is at the end of the vault. The usual inside dimensions of the tank are 3 ft. 9 ins. by 1 ft. 10 ins., with water 4 ft. deep, giving a capacity of about 200 galls. The tank connects with the vault by means of two 12-in. glazed earthen drain pipes, the curve having a radius of about 5 ft.

The flap-valve shown by Fig. 3 is operated by a chain connection with an ordinary windlass above. One turn of the windlass lifts the valve. As shown by Fig. 3, the bell mouth of the outlet pipe reaches up nearly to the bottom of the tank. A valve seat is formed by a cast-iron ring with a face 2½ ins. wide flush with the bottom of the tank, and an inside rim 4 ins. long which projects into the end of the drain pipe. The ring is ½ in. thick and is screwed to the bottom of the tank, the joint being made tight by a rubber gasket.

The valve proper is of cast-iron, hinged to the bottom of the tank, as shown. It is faced with ⅛-in. sheet rubber, held in place by screws extending through the iron and rubber into a piece of wood, cut to shut into the iron ring. The hinge is not rigid, the bolt being ⅞ and the bolt-hole ¾-in. in diameter.

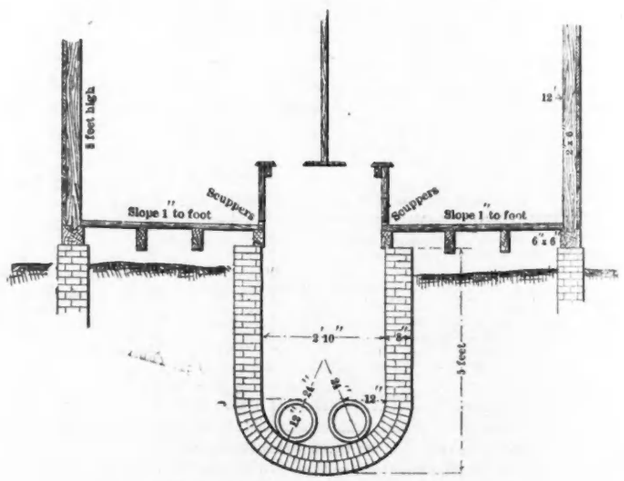


FIG. 3. FLAP-VALVE FOR FLUSH TANK.

The Cost of Pipe and Brick Sewers, Manholes and Catch Basins.

The first annual report of the Troy Public Improvement Commission contains a large table of information concerning the sewerage systems of nearly 50 cities in the eastern, southern and central part of the United States and one in Canada. The figures for cost, where given with sufficient completeness, are presented in the table I., together with such other information as is needed for their intelligent consideration. As would be expected, there is a large difference of cost in the various cities, which is not always explained by the depth at which the sewers are laid, and cannot be accounted for within the limits of a table. For instance, 8-in. pipe sewers at Augusta, Ga., cost but 25 cents per foot and are laid from 5 to 10 ft. below street grade, while at Cincinnati they cost $1.50 and are laid at an average depth of 10 ft. Sixty-inch brick sewers in Philadelphia cost but $5 per foot in Lawrence, Mass., $10, and in New Haven, Conn. $16.67. The depths at which sewers are laid in each city are 10 to 15, 7½ to 8 and 10 to 12 ft., respectively. The figures for brick sewers are not properly comparable, however, judging from the sizes and shapes given.

In table II. the average, highest and lowest prices are given for the several sizes, the brick sewers being included with the caution given above.

TABLE I.—COST OF PIPE AND BRICK SEWERS, MANHOLES AND CATCH BASINS.

City.	Length of sewers. Total.	Pipe.	Brick.	Sizes. Pipe, ins.	Brick.	Cost of sewers. Pipe. 8 in.	10 in.	12 in.	15 in.	18 in.	24 in.	Brick. 30 in.	36 in.	48 in.	60 in.	Manhole.	Catch basin.	Average depth below street grade, ft.
Philad'phia, Pa.	332	25	307	8 to 15	18 × 27 ins., to 20 ft.		82 to $2.25		2 25	2.25		2.25	2.25	....	5.00	25	89, 86, 81	10 to 15
Rochester, N.Y	132	67	65	9 to 24	3 ft.			1.00	1.25	1.50	2.50	...	5.00	....	....	35	.....	7 to 10
N. Haven, Conn.	53	28	25	9 to 24	24 × 78 ins.			1.29	1.68	2.05	....	4.28	5.83	7.50	16.47	60	135.00	10 to 12
Altoona, Pa.	20	13	7	6 to 18	2 × 3 ins., 4.6 to 6.9 ins.							3.00	3.20	6.70	....	30	75.00	10 to 12
Lincoln, Neb.	2¾	21¼	5½	6 to 20	20 to 60 ins.	.10	.45	.60	.75	1.00	1.55	....	4.50	5.60	6.50	60	60.00	8 to 12
Erie, Pa.	23	14	9	12 to 20	18 to 54 ins.			1.40	1 85	3.05	3.70	4.20	....	....	....	50	30.00	10
Chicago, Ill.	650	325	325	12 to 18	2 to 9 ft.			95	1.07	1.40	1.70	2.22	3.25	4.14	....	....	42.50	.....
Council Bl'f's, Ia.	13¼	10	3¼	8 to 24	2 to 5 ft.	.40	.46	.54	.64	.82	1.65	1.82	2.60	....	5.20	28	30.00	6 to 8
Cambr'ge, Mass	81	34	44	8 to 18	12 × 15 ins., 96 × 100 ins.	.82	.95	1.14	1.50	1.75	2.00	2.12	....	....	....	40	75.00	9
Lit. Rock, Ark.	12	12	....	6 to 24	.....	.....	.....	.....	.....	.....	2 50	.....	.....	.....	.....	45,60	50, 70	10
Grand Rapids, Mich.	47	27	18	9 to 22	5 × 6 ft., 14 × 21 ins.	.....	.....	1.25	.....	.....	.....	.....	.....	.....	.....	30	26, 36	8
East Saginaw, Mich.	29	11	19	12 to 18	4 to 6½ ft., 30 to 84 ins.	.....	.....	.65	.70	.80	....	.....	.....	4.50	6.00	35	15.25	10 to 18
Halifax, N. S.	28	5	12	9 to 15	12 × 18 ins., 6 ft. circ.	.....	.....	1.50	1.75	1.80	2.10	2.30	5.25	6.50	8.00	80	50.00	9 to 11
Elmira, N. Y.	14	9	5	12 to 24	2 × 3 ft., 4 × 6 ft.	.....	.....	1.10	.....	.....	2.25	....	3.00	4.00	....	30,35	18.00	10 to 12
Lancaster, Pa.	5	.....	5	.....	1½ to 6 ft.	.....	.....	.....	.....	.....	.....	1.00	1.25	1.50	2.00	60	.....	7
Cincinnati, O.	95	47½	47½	12 to 24	2 to 14 ft.	1.50	1.75	2.00	2.25	2.50	3.00	4.00	5.00	7.50	9.00	40	75.00	13
Buffalo, N. Y.	200	100	100	9 to 24	2 to 9½ ft.	....	1.00	1.00	1.20	1 50	2.00	2.60	3.25	4.50	5.50	45	Iron 75.00	9 to 20
Allegheny, Pa.	38	22	16	15 to 24	30 ins. to 10 ft.	.....	.....	.....	1.50	1.75	2.25	4.00	4.50	5.50	7.00	32	50, 110	11 to 12
Akron, O.	11	7	4	6 to 18	2 ft. r'd to 55 × 72 ins.	.30		.30	1.50	....	2.50	2.50	2 50	9.00	9.00	40	35.00	9
Dubuque, Ia.	11¼	6	1	8 to 24	30 ins. to 6 ft.	.65	.70	.80	1.00	1.30	1.60	2.65	....	....	....	32	.....	10
Boston, Mass.	270	90	180	8 to 18	12 × 16 ins., 12 ft. (!) × 12 ins.	1.50	1.50	1.50	1.75	2.00	3.00	3.50	3.75	5.00	8.00	45	125.00	10
Lawrence, Mass	34	17	17	10 to 18	20 to 69 ins.	....	1.15	1.30	1.70	2.10	2.25	4.40	4.90	6.25	10.60	60	50.80	7½ to 8
Camden, N. J.	32½	½	32	12 to 15	18 to 27 ins., 6 ft.	.....	.....	.90	1.10	....	...	1.30	1.50	3.00	6.00	9	75.00	8
Newark, N. J.	77	30	47	10 to 18	2.6 × 3.6 to 5 ft.	.55	.80	.88	1.12	1.36	1.55	3.20	3.46	5.63	6.55	28	100.00	10
Augusta, Ga.	17	7	10	8 to 18	20 to 72 ins.	.25	.35	.38	.65	.70	....	1.13	1.82	2.85	4.09	.....	35.00	5 to 10
Milwaukee, Wis	179	118	61	12 to 18	24 to 96 ins.	.....	.....	1.25	1.35	1.65	..	3.10	3.65	4.75	7.00	.....	.....	10½ to 13½
Detroit, Mich.	271	....	271	.. ..	15 × 20 ins., 9 ft. circ.	.....	.....	.....	.....	.....	.....	.....	1.20	.....	.....	4.50	25,60	55.00	4½
Omaha, Neb.	75¼	63¼	10	6 to 24	2 ft. 6 ins. to 8 ft. 6 ins.	.70	.80	.90	1.10	1.40	2.75	3.80	3.90	4.00	9.80	70	25 00	12½
Bloomg'ton, Ill.	6	4	2	8 to 18	2½ to 8 ft.	.....	.....	.60	.70	1.00	.....	.....	2.00	....	4.00	30	.....	10
Cohoes, N. Y.	8	7½	....	10 to 24	.....	.....	.75	.80	.90	1.25	2.10	....	.....	.....	6.00	.....	90.00	9
Providence, R.I	61	42	18	12 to 18	16 to 66 × 72 ins	.....	.....	1.48	1.82	2.00	3.70	4.33	5.05	6.41	7.80	47½	50, 93.76	11
Burlington, Vt.	13	10½	2½	8 to 18	12 to 72 ins.	1.00	1.14	1.25	1.50	2.15	....	3.70	3.67	4.00	....	60	125.00	10
Kans. City, Mo.	107	...	...	10 to 21	2 to 8 ft.	.....	.....	.85	1.00	1.40	....	2.45	3 50	3.90	4.60	40	25.00	12
Syracuse, N. Y.	40	20	20	12 to 24	18 to 96 ins.	.40	.50	.70	1.00	1.25	1.60	2.50	3.25	4 00	7.60	25	25.00	10
Kingston, N. Y.	4	4	4	8 to 20	.....	.77	.....	.....	.88	....	1.37	.....	.....	.....	.....	35½	.....	9
Portland, Me.	39	22	14	10 to 24	12 ins., 40 × 60 ins.	.64	1.02	1.36	2.39	1.87	2 54	3.03	3.97	7.76	8.36	42½	80, 95.00	7½ to 9

TABLE II.—AVERAGE HIGHEST AND LOWEST PRICES PAID FOR SEWERS OF VARIOUS SIZES.

Size of Sewer, ins.	No. of cities included.	Average.	Highest.	Lowest.
8	14	$ .71	$1.50	$ .25
10	15	.89	1.75	.35
12	39	1.07	2.25	.30
15	29	1.30	2.39	.54
18	27	1.61	3.05	.70
24	24	2.27	3.70	1.37
30	27	2.81	4.40	1.00
36	27	3.55	5.83	1.25
48	24	5.19	9.00	1.50
60	25	7.30	16.47	2.00

THE NEW YORK & NEW JERSEY BRIDGE companies were consolidated last week, with a stock capital of $15,000,000, and bonds to the amount of $60,000,000. These bonds are for 50 years, redeemable at the end of 20 years by paying principal and 10% premium, with interest to date. Mr. THOMAS C. CLARKE is Chief Engineer of the new company.

LOCOMOTIVES FOR BRAZIL are being sent out in considerable numbers from this country. The Bureau of American Republics states that 128 engines have been shipped by the Baldwin Locomotive Works, of Philadelphia, Pa., since the date of the reciprocity treaty with Brazil, and in addition to these a shipment of 24 engines has just been made. The number includes 11 compound engines for various roads, some standard and some narrow gage, and 17 compound engines for the Brazil Central Ry. (formerly the Dom Pedro Segundo Ry.).

THE GALVESTON ARTESIAN WELL is now 2,040 ft. deep and is still being sunk. It is 9 ins. in diameter and to 1,510 ft. is in a sand formation; then come about 100 ft. of gray and green clay mixed with wood, lime concretions and pebbles; 42 ft. of sand; 6 ins of very hard rock; 106 ft. of sand; 4 ft. of rock; 113 ft. of sand; 10 ft. of mottled clay; 12 ft. of sand and 109 ft. of brown and gray clay. The age of the wood noted above is estimated at 200,000 years by Prof. G.A.Singley, and in this stratum he also found seeds resembling "apple and hackberry seeds."

FREEZING UP OF PIPES IN STEAM HEATED CARS has been guarded against on the Maine Central R.R., by issuing a general order warning conductors to make sure that the trainmen under their charge fully understand the workings of the system of steam heating used (the Sewall), and know how to operate it to obtain the best results with the least expenditure of steam. When cars are set off or left for the night in freezing weather, special instructions are given to open all valves both outside and inside the car and permit the condensed water to drain off.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Maine Central.—This company has promised to guarantee $75,000 of 4% bonds to aid in building the proposed extension of the Skowhegan & Norridgewock R. R. The citizens of Skowhegan, Me., have subscribed $20,000 more in aid of the enterprise. Surveys are now in progress, and work is expected to begin in the spring. The extension will be about 3 miles long.

Wild River.—The Wild River Lumber Co. of Maine has nearly completed its road to the mills and timber lands owned by it.

Philadelphia & Reading.—The surveys for the proposed cut-off from Edge Hill, Pa., to a connection with the Bound Brook branch are nearly completed.

Orford Mountain.—Steel rails for 10 miles of this railway between Eastman and Lawrenceville, P. Q., have arrived and track laying will begin at once, and this section of the road completed by Nov. 15. C. C. Smith & Co., of Montreal, P. Q., are the contractors.

Rochester & Honeoye Valley.—It is stated that this railway from Rochester, N. Y., to a connection with the Buffalo & Geneva R. R., will be completed within six weeks.

Findlay Belt Line.—This company has under consideration an extension 5.6 miles long to connect with the New York, Chicago & St. Louis R. R.

Projects and Surveys.

Syracuse & Oneida Lake.—Chartered in New York to build a line of railway from Messina Springs, Onondaga Co., N.Y., to a point on the south shore of Oneida Lake, a distance of 12 miles. The capital stock is $125,000.

Chicago & Southeastern.—Chartered in Indiana, presumably in the interest of the Toledo, Peoria & Western R. R., to build a railway from the eastern terminus of that road on the Illinois state line southeast to a point on the Ohio state line, a distance of about 250 miles, with a branch from the main line in Pike Co., Ind., to Brazil, Ind. Among the incorporators are Chas. S. Harris, L. G. English and E. A. White, of Chicago, Ill.

Sewickley & Jeanette.—Chartered in Pennsylvania to build a railway from a point on the north bank of the Youghiogheny River, Huntingdon Township, Westmorland County, Pa., up the Big Sewickley Valley, via Verona and Adamsburgh, Pa., to Jeanette, Pa., a distance of 15 miles.

Middletown & Odessa.—It is stated that arrangements have been completed for marketing the bonds of this company and that the road will be completed by Jan. 16, 1892. Wm. R. Polk, of Middletown, Del., is at the head of the enterprise.

Bangor & Aroostook.—The locating surveys of this railway are now completed from Brownsville to Presque Isle, Me. As soon as the surveys are completed to Caribou work will be commenced.

Mattawa & Temiscamingue.—Construction has been commenced upon this proposed railway from Mattawa, Ont., to Lake Temiscamingue, a distance of about 70 miles.

Ives Branch.—A company has been organized by New York and Connecticut capitalists to build a railway from Danbury, Conn., west to the New York State line, where connection will be made with the New York & Harlem R. R. The officers of the company are: Samuel C. Holly, president; Daniel Meeker, vice-president; Edward M. Barnum, secretary, and Alfred M. Wildman, treasurer. All surveys have been made.

Dansville & Mt. Morris.—Incorporated in New York Oct. 21 to operate a railroad from Dansville to Mt. Morris, by Ambrose S. Murray, Jr., of 32 Nassau St., New York City, August Stein, of Hoboken, N. J., and others. Capital stock, $500,00.

SOUTHERN.—Existing Roads.

Louisville & Nashville.—It is stated that this company has let the contracts and ordered the work commenced on the extension of the Birmingham Mineral R. R., from Oneonta to Bridgeport, Ala. Work is expected to begin in a few weeks.

Chesapeake & Ohio.—The surveys for the belt line transfer railway at Richmond, Va., are now nearly ready to be reported upon. A terminal bond of $1,000,000 will probably be issued to provide for this and other improvements.

Chickamauga & Durham.—This 17½-mile railway from Chickamauga, Ga., to the coal fields of Round Mt., is now under construction.

Nashville & Tellico.—This Tennessee railway has, it is stated, been sold to New York and Boston capitalists, who will extend it from Athens to Dayton, Tenn.

Canaveral & South Florida.—This company proposes to extend its Banana River branch to a point near Kissimmee, Fla.

Florida.—John B. Crilly, of Tampa, Fla., has advertised for aid in constructing a railway 30 miles long. The line will run through a good timber region, and can be built for about $3,000 per mile. It is stated that liberal land grants can be obtained in aid of the road. Three miles are now in operation, with one locomotive and three logging cars.

Covington, Flemingsburg & Ashland.—It is stated that this company will build extensions to the Newport News & Mississippi Valley R. R., and to Marysville or Cincinnati, O.

Projects and Surveys.

Middle Georgia & Atlantic.—We have received the following letter from W. Arthur Pew, Chief Engineer of this road:

In your last issue I am quoted as saying that the Middle Georgia & Atlantic Ry. will pass through certain towns. In filling out the blanks you sent me for information in regard to this line I stated that the line would pass "through or near" certain towns. The line is not yet located, and on account of my official position I would not wish to be quoted as saying that it will pass through those towns when it may miss some of them four or five miles.

Engineering work seems to be very scarce. I have a dozen applications from men who seem to be competent resident engineers offering to take the rod, chain, axe, anything. On the corps running the first preliminary last summer, the rodman, both chainmen and the stakeman could run either instrument. To prevent needless applications will say that I have already selected engineers to fill every vacancy that will probably occur within the next six months.

Ducktown Mineral.—Preliminary surveys for this railway are now completed and estimates are being made. It will probably be built in the near future, as English capitalists are spending large sums of money testing the copper and iron mines at Ducktown. F. O. Sinclair, of the firm of Sinclair & Leavenworth, Chattanooga, is Chief Engineer.

Montgomery, Hayneville & Camden.—This company has completed its organization by electing Jacob Greil President and J. W. Durr Secretary. It was decided to begin construction at once.

Unaka & Nolachucky.—The citizens of Newport, Tenn., have voted to subscribe $30,000 in aid of this Tennessee railway.

Florida, Georgia & Carolina.—The officers of this company, recently organized to build a railway from Asheville, N. C., to Tampa, Fla., are: F. J. Kline, Milledgeville, Ga., Vice-President, and W. C. Guiers, Mt. Carmel, S. C., Treasurer.

Georgia. Bills chartering the East & West R. R. Co., the Overstreet R. R. Co., and the Albany & Bainbridge R. R. Co., have passed the Georgia State Legislature.

NORTHWEST.—Existing Roads.

Burlington & Missouri River.—This company has announced that it will at once build a spur from Englewood Station, S. Dak., to the Ruby and Bald Mountain mining districts of the Black Hills, a distance of 8 miles. The surveys have been made and contracts let, and work will begin at once.

Great Northern.—Grading has been completed on the line from Red Lake Falls to St. Hilaire, Minn., 8 miles, and tracklaying is now in progress. — Surveys are reported in progress for an extension of the Wadena & Park Rapids Branch toward Forston, Minn.

Kewaunee, Green Bay & Western.—Tracklaying will be completed between Kewaunee and Green Bay, Wis., 34 miles, in a few days.

Canadian Pacific.—Grading has been begun on the proposed extension of the Southwestern Branch to a connection with the Souris Branch. The connection will be made at Napinka, Man., instead of at Melita, as was first intended. The contractor is James Ross.

Calgary & Edmonton.—Contractor James Ross is reported as saying that work was making very satisfactory progress upon the southern branch of this road.

Projects and Surveys.

Duluth, Mesabi & Northern.—Work has been begun clearing the right of way of this road from near Duluth north to the Mesabi mining district. An official of the company is reported as saying that the road will be built by the company and that no contracts will be let. It is expected that the first section of 46 miles from the mouth of the Artichoke River, near Duluth, north to the Mountain Iron mine, will be cleared ready for grading in about 60 days. It is estimated that the cost of grading will be about $220,000 or less than $5,000 per mile, and that the track will cost $3,500 per mile.

SOUTHWEST.—Existing Roads.

Mississippi River & Boune Terre.—The grading has all been completed on the line from Boune Terre to Doe Run, Mo., 15 miles. Track laying will begin at once.

Illinois Central.—A press dispatch says that this company will extend its line from Brookhaven to Natchez, Miss., and will purchase the line running from Natchez to Trinity, La., and extend it to Alexandria, La.

ROCKY MT. AND PACIFIC.—Existing Roads.

Southern Pacific.—Work is in progress upon an extension of the Bay Shore line from San Bruno, Cal.

Santa Fe, Prescott & Phœnix.—The contract for building this line from Phœnix, Ariz., to a connection with the Atchison, Topeka & Santa Fe R. R. has been let to B. Tooby, of Phœnix, Ariz., and work has been commenced.

Great Northern.—Tracklaying has been completed on the Seattle & Montana R. R. About 200 miles of the Pacific Extension are now completed.

Denver, Lakewood & Golden.—This company has completed the survey of its proposed branch to the mines of the Denver Coal Co., at Rolston, Colo. Construction will be pushed and the line completed in 60 days.

Northern Pacific.—It is expected that the extension to Acosta, Wash., will be completed and ready for operation before the close of the year. Only about 7 miles remain to be completed.——It is reported that a line will be built from Acosta to South Bend, Wash.

Projects and Surveys.

Port Angeles Southern.—An official of this road is reported as saying that the engineers are now making the final location of this Washington railway, and will have it finished in about 15 days. As soon as this is completed construction will be commenced. There will be no large bridges and no large cuts or fills, and it is estimated that it can be built for $300,000.—Mr. C. E. Mallette, of Port Angeles, Wash., sends us the following information concerning this road:

Surveys are about half completed on this road, which is projected to extend from Port Angeles via Rena and Seguin Bay to Junction City, about 35 miles. The line was through a comparatively level country, but there will be three large bridges. Considerable right of way has been secured and the company has a land subsidy of $300,000. Contracts will probably be let about the first of 1892. Mr. F. S. DeWolfe is President and A. J. Blackwood is Chief Engineer.

Denver & El Paso Short Line.—The city of Denver, Colo., has voted $1,000 to aid in making a survey of this proposed railway from Denver, Colo., to El Paso, N. Mex.

Tacoma, Edison & Puyallup.—Chartered in Washton to purchase the Tacoma & Puyallup R. R. and the Wapato Park Belt Line Ry. Among the incorporators are: T. B. Wallace, of Tacoma, Wash., and Frank O. Meeker, of Puyallup, Wash.

Woodland & Elkhorn.—A project is on foot to build a railway from Woodland to Elkhorn, Colo.

FOREIGN.

International Ry. Co., of Mexico.—This company has been formed to build a railway from the International line south to some point on the frontier of Guatemala, with a branch from near Tuxpam to the City of Mexico.

China.—Negotiations are said to be in progress between the Russian and Chinese governments looking toward the construction of a railway from Vladivostock, Siberia, across the northern border of Corea to Tien-Tsin, and thence through Northeastern China to Shanghai.

CITY TRANSIT.

Electric Railways.—***Hartford, Conn.***—The Hartford & Wethersfield Horse Ry. Co. has been granted permission to erect poles and wires for an electric system.

Brooklyn, N. Y.—The Atlantic Avenue R. R. Co. expects to have electric cars running on the Atlantic Ave. and Fifth Ave. lines from South Ferry to Greenwood Cemetery by next May. Permission was granted by the Railroad Commissioners in June.

Scottdale, Pa.—The Nickel Plate Street Ry. Co. has been organized by Joseph Herbst, Monroe Morrison and W. C. Morrison of Mt. Pleasant. Capital stock, $12,000.

Wilmington, N. C.—An ordinance for an electric line has been granted to the Wilmington Street Ry. Co.

Gadsden, Ala.—The Gadsden & Attalla Union Ry. Co. has decided to change its dummy line to an electric system.

East Liverpool, O.—The contract for electrical equipment for the East Liverpool & Wellsville Ry. has been awarded to the Short Electric Ry. Co. The road will be about 8 miles in length, connecting Ohio City, Wellsville and East Liverpool, and having the power station in the last named place. Johnson girder rails, weighing 82 lbs. per yd., will be used. A force of 500 men has been at work for two weeks on the roadbed, which will be practically level. In East Liverpool 13 acres of ground have been purchased, on part of which a brick power station is in process of erection. Power will be furnished by two 150-HP. Reynolds-Corliss engines, with two 300-HP. boilers and a Worthington duplex pump. Two Short multipolar slow speed dynamos of 150 HP. each, and a marbleized slate switchboard of the latest Short type, fitted with all necessary appliances will complete the equipment of the power station. Seven 26 ft. car bodies have been purchased from the J. G. Brill Co., Philadelphia, Pa., and these will be equipped with 14 Short "gearless" motors, having a capacity of 20-HP. each. The line construction will be the Short system throughout.

Sioux City, Ia.—A trial of the Bradbury-Stone storage battery car was made recently on the Riverside line. The car weighed 12,000 lbs. The test was made in the presence of W. F. Weyburn, J. T. Bradbury, Mr. Mack, electrician of the cable road, W. Kramer, E. M. Dunbar and others interested in the new company which has been formed to manufacture the storage battery.

Woodland, Cal.—An electric railway to Elkhorn is projected.

Horse Railways.—Savannah, Ga.; Southover Street Ry. Co.; J. L. Wheatley, C. H. Olmstead and C. H. Dorsett, $10,000. Macon, Ga.; North Macon Street Ry. Co.; E. B. Waters, R. E. Park and R. F. Ousley; $5,000.

Dummy Railway.—Madison, Ga.; Madison & Eatonton Dummy Line Co.; J. H. Holland and J. K. Wright, of Madison; T. J. Ingraham and J. H. Adams, of Eatonton; $200,000.

HIGHWAYS.

Rhode Island.—The roads in Lonsdale will be repaired soon by the Highway Committee of the town of Cumberland.

Florida.—The Ocala & Silver Springs Co. will build a boulevard 6 miles long from Ocala to the springs; it will be 200 ft. wide. H. C. Dean, of New York, is General Manager.

WATER-WORKS.

NEW ENGLAND.

Berlin, N. H.—Water-works and sewers are being talked of, and a meeting of the Berlin Aqueduct Co. has been called.

Groveton, N. H.—Works are talked of.

Portsmouth, N. H.—Business men are talking of bringing in water from Jones Pond, about 2 miles distant. The present works were built by a company and are small.

The Weirs, N. H.—Surveys are being made for water-works and sewers. Works have been projected for some time by the Weirs Water-Works Co.

Bradford, Vt.—Edward Gustine, Keene, N. H., will have charge of the construction of the new works. A dam about 8 ft. high will be built across a stream nearly 300 ft. above the village. Some 8,700 ft. of pipe will convey water to a 1,000,000-gall. distributing reservoir about 200 ft. above and 1,500 ft. from the village. About 3,000 tons of 8, 6 and 4-in. mains will probably be used.

Danville, Vt.—A recent fire has brought the need for water-works before the people, but nothing has yet been done.

East Bridgewater, Mass.—H. H. Thorndike, Superintendent, informs us that the company will build a dam to impound spring water and lay two miles of mains.

Stockbridge, Mass.—The company has voted to increase its capital stock $30,000 and, it is reported, introduce a new supply from Lake Averic.

Worcester, Mass.—An 8-in. cement main will be replaced by 12-in. cast-iron pipe.

Woonsocket, R. I.—A $200,000 4% loan is proposed for funding the city's floating debt and for water-works improvements.

Waterbury, Conn.—An examination and report upon a new water supply will be made by Rudolph Hering, New York.

MIDDLE.

Laurens, N. Y.—The agitation for works continues.

Le Roy, N. Y.—The trustees have instructed the clerk to secure information as to the cost of water-works. Fire protection is now furnished under a contract which now has three years to run.

Fishkill and Matteawan, N. Y.—The Matteawan Board of Trade is discussing village works. The present supply is from a company, and it is stated that for three years out of five the supply has been inadequate in the summer.

Mechanicsville, N. Y.—Nov. 3 the people will vote on the proposed works.

Newburg, N. Y.—The commissioners have rescinded their request for an election to vote on the issuance of $75,000 for improvements, and have voted to employ J. D. Van Buren to make a preliminary examination of the water supply.

East Orange, N. J.—The Orange Water Co. has made a proposition to sell its works to the township.

Palo Alto, Pa.—The Borough Council has voted to accept the proposition of the Pottsville Water Co. to supply water to residents of Savory St. The borough must secure 40 consumers at $6 each, and guarantee an additional sum of $500.

Stockton, Pa.—A company to supply the villages of the township, a suburb of Camden, N. J., is projected by George Pfieffer, Jr.

SOUTHERN.

Aiken, S. C.—A report on proposed works is to be made for the council by J. C. Chase, Wilmington, N. C.

New Berne, N. C.—Address W. D. Wallace, City Clerk, regarding proposals for city works.

Columbus, Ga.—There is some talk of the purchase of the company's works by the city.

Bartow, Fla.—The Council has granted a water-works franchise to the Tube Well Co., and has transferred to it an electric lighting franchise.

Glasgow, Ky.—The pumping station was burned Oct. 18. Crude oil was used as fuel, some of which had been spilled upon the floor. Live coals, it is said, were thrown upon the oil to burn it off, and as a result the building was burned.

Princeton, Ky.—The Trustees will employ an engineer to report on proposed works.

Standford, Ky.—Address Mayor W. Vandevear or J. S. Hughes regarding bids for building works.

NORTH CENTRAL.

Brookville, Ind.—We are informed that the Laidlaw & Dunn Co., Cincinnati, has the contract for pumping machinery for the new works.

Elkhart, Ind.—Experimental wells are being sunk to locate a large well for an increase to the supply.

Nappanee, Ind.—The contract for works has been let by the city to Fairbanks, Morse & Co., Chicago, for $12,000. There will be a stand-pipe and 2 or 3 miles of mains.

Cannelton, Mich.—Bonds for works to the amount of $10,000 have been voted.

Edmore, Mich.—Works are being discussed.

Jackson, Mich.—The following is from J. K. Bogert, Secretary Board of Public Works:

W. S. Parker has been engaged as consulting engineer for the water-works improvements. The $150,000 issue of water bonds has been sold to Adams, Blodgett & Co., Boston, at a total premium of $2,386.

Kalamazoo, Mich.—We are informed that W. R. Coats has recommended a 2,000,000-gall. elevated reservoir, or tank, be added to the present direct pumping system. For pipe connections, 2,000 ft. each of 24 and 16-in. and 1,400 ft. of 20-in. mains would be necessary.

Mancelona, Mich.—The sum of $15,000 has just been voted for works.

Ridge Farm, Ill.—It is reported that works are to be built.

Tolono, Ill.—Water has been secured from a new 150-ft. public well, and there is now talk of building works.

NORTHWESTERN.

Beatrice, Neb.—The contract for improvements has been awarded to Godfrey & Meals, Fremont, for $3,834.

SOUTHWESTERN.

Kirksville, Mo.—A vote will be taken Nov. 3 on the issuance of $38,000 of bonds for water and electric lights.

Beaumont, Tex.—Bonds to the amount of $6,000 will be issued to extend the works.

Giddings, Tex.—An effort is being made to organize a company.

Hondo City, Tex.—S. B. Easley, C. A. Jackson and others compose the Hondo City Water-Works Co., now building works.

Orange, Tex.—It is reported that a water company has been organized.

Rockdale, Tex.—The Improvement Co. has completed a well 5 ft. in diameter and 62 ft. deep.

Boulder, Col.—The reservoirs will be lined.

New Mexico.—It is reported that new pipe is to be laid from the Atchison, Topeka & Santa Fé pump house near old Ft. McRae to Engle; also that a pipe line is to be laid from a spring some six or eight miles to Magdalena.

Colfax, Wash.—Bids are wanted by the city until Nov. 5 for a supply well and receiving basin, a 1,000,000-gall. pumping plant, 500,000-gall. reservoir, about five miles of 10 to 4-in. pipe, 38 10 to 4-in. stop gates, hydrants and all labor. Address Chairman Committee on Fire and Water.

PACIFIC.

Tekoa, Wash.—The Council will receive bids for building works until Nov. 1. C. F. Lake is city clerk.

Colton, Cal.—Regarding the report that the city is to build works independent of those now owned by the company, G. E. Slaughter informs us that the city has bought about two acres of artesian lands and engaged an engineer to report on works. It is expected that bonds will be voted this fall.

San Rafael, Cal.—T. S. Bouneau, Clerk of the Marin County Supervisors, will receive bids until Nov. 10 for a 50,000-gall. redwood water tank to be located at the poor farm near San Rafael.

ARTESIAN WELLS.

Pittsfield, Mass.—The sinking of 50 wells near the water-works reservoir to obtain an additional supply of 2,000,000 gallons daily is proposed.

Fairbury, Ill.—An election will be held Nov. 5 to vote on the issuance of $15,000 for an artesian well and water-works extensions.

Giddings, Tex.—Money is being raised for a well.

Albuquerque, N. M.—The Albuquerque Artesian Co. has been incorporated by J. A. Lee, H. B. Ferguson and others: capital stock, $10,000.

Jacksonville, Ore.—Artesian wells are projected to develop water for irrigating the portion of the lower Rogue River valley known as the desert.

IRRIGATION.

Bakersfield, Cal.—It is said that the "'78 Canal" will soon be built.

Oroville, Cal.—A canal 60 ft. wide is to be built to irrigate lands in Butte and Sutter Cos. Water will be taken from the Feather River, near here. W. B. Hayford, Colfax, will be Manager.

San Bernardino, Cal.—The Arrowhead Reservoir Co. wishes bids until Dec. 15 for constructing three tunnels, 4,900, 3,600 and 2,000 ft. long.

Idaho.—The Idaho Canal Co. has let a contract for a canal across the Fort Hall reservation. By spring it is hoped to have canal completed to Pocatello.

New Companies.—Tulare Lake Canal Co., San Francisco; $50,000; to distribute water from Tule River; E. B. Pond, C. L. Taylor and others. California Land & Water Co., San Francisco; W. A. Horney, A. T. Sherwood and others. Cañon Ditch Co., Missoula, Mont.; $50,000.

SEWERAGE AND MUNICIPAL.

Sewers.—***New Hampshire.***—Berlin. The Berlin Aqueduct Co. is considering the question of water supply and sewerage. — The Weirs. Surveys are being made for the proposed water supply and sewerage system. — Laconia. The selectmen have been authorized to make a contract with the Laconia & Lake Village Water-Works Co. for supplying water for flushing the new sewers. The annual expense of the maintenance of the sewers is estimated at $5,400. Mr. F. G. Berry has been elected Superintendent of Sewers. By-laws have been adopted.

Rhode Island.—Providence. Mr. Smith, Commissioner of Public Works, is reported as saying that the only action ever taken by the City Council in the matter of precipitation tanks was the acceptance of City Engineer Gray's general plan and ordering definite plans made. That was when the City Engineer's department was independent of the Department of Public Works. An extra appropriation was expected, but never made. The plans have never been commenced because the City Engineer's department has had all the work it could do on the new improvements, Fruit Hill reservoir, &c., with the appropriations which have been made. The commissioner is pushing the work on the improved sewerage system and is taking care of the sewage from the Gorham Mfg. Co.'s works by pumping it into a tank and carting it off.

New York.—Brooklyn. A relief sewer is to be built to drain the flooded district of the 23th ward. It will be 24 ins. diam. and cost $16,000. The contract for the 2d ward sewer has been let to McKiernan & Bergin, and for the N. 3d St. sewer to Samuel Crawford.

South Carolina.—Greenville. A system of sewers to cost $75,000 is proposed.

Ohio.—Fostoria. A system of sewers is being built at a cost of $75,000.——Middletown. The contract for the 3d St. sewer has been awarded to Berry & Mehan, of Middletown. It will consist of 670 ft. of brick, 30 ins. diam.; 380 ft. of 24-in. pipe, 750 ft. of 18-in. pipe, 420 ft. of 15-in. pipe, 1,300 ft. of 12-in. pipe, 322 ft. of 10 in. pipe, 240 ft. of 8-in. pipe, and 31 ft. of 6-in. pipe, with Ys, slants, catch-basins, manholes, &c.

Illinois.—Blue Island. Contracts are to be advertised shortly for a sewerage system to cost $150,000.

Utah.—Ogden. Contracts will be let shortly for sewer district No. 3; the work will cost about $17,000.

California.—Los Angeles. The necessity for improved sewerage has been discussed by the Council and the Board of Trade.—South Berkeley. A plan for a system of main sewers, located according to districts, has been prepared by Mr. King, the engineer.

Manitoba.—Winnipeg. A proposition has been accepted from Kelly Bros. & Co to build sewers at a price 10% above the engineer's estimate.

Street Work.—***Massachusetts.***—Lawrence. About 55,000 granite blocks will be required for Essex St.—Lincoln. An appropriation of $12,000 has been made for paving Main St.—Boston. The proposed appropriation of $1,500,000 for street widening and improving has been defeated.

New York.—New York. The estimates for 1892 include $650,000 for streets and avenues. Syracuse. The Syracuse Consolidated Ry. Co. is having surveys made for a boulevard round Onondaga Lake, with a view of building an electric railway.

Pennsylvania.—Philadelphia. The main items in the next year's estimate are $300,000 for improved pavements to be laid on streets not occupied by the passenger railway track, $200,000 for paving intersections and unassessable properties, $150,000 for repairs to improved streets, $75,000 for repairs and maintenance of unpaved streets and country roads, $30,000 for general repairs to bridges, with the same amount to be expended in repairs and alterations to sewers and inlets, and $40,000 for crossing and gutter stones and repaving tramway streets with Belgian blocks. The Director asks for $611,920 wherewith to clean the streets, collect garbage and ashes in 1892, an increase of $48,000 over the amount of $563,920 given for the same purpose in 1891.

Tennessee.—Chattanooga. The contract for granite block paving on Cowart St. has been awarded to J. A. Gillespie at $11,548.

Ohio.—Massillon. Engineer Miller has completed plans and specifications for paving East Main St. Proposals are wanted for 543,250 paving brick per M; tarring, per sq. yd.; excavating, per sq. yd.; graveling for foundation, per cu. yd.; laying brick, per M.; and all other material and labor required. The specifications require that the street shall be excavated to a depth of 9 to 12 ins. The surface is to be given a dressing of clean gravel six ins. deep, and on top of this 2 to 2½ ins. of fine sand, upon which the brick is to be laid.

Missouri.—St. Louis. A system of boulevards is proposed by the Board of Public Improvements.—Hannibal. The cost of paving Broadway, including sidewalks, is estimated at $60,000.

Colorado.—Denver. The Denver Tramway Co. is experimenting with vitrified brick made in Denver, and if they stand the test they will be used by the company in paving between the rails of its car lines not already paved.

California.—Vallejo. The city clerk has been authorized to advertise for proposals for 500 tons of macadam for the streets.

Bonds.—Buffalo, N. Y.; $150,000 refunding bonds. Gadsden, Ala.; $25,000, 30 years, 6%, to be issued in November. Columbus, Ga.; $175,000 for sewerage system. Pittsburg, Pa.; $2,000,000, 10 years, 5%, for street improvement. Wheeling, W. Va.; $80,000 for electric light plant; $60,500 bridge bonds, bids received Nov. 2. Gilroy, Cal.; $50,000 for water-works. Newark, N. J.; $500,000 for paving. Boston, Mass.; $1,573,000 for public improvements. Omaha, Neb.; $36,500 for grading. John Ruse, City Treasurer, Nov. 7; $50,000 for sewers. Manchester, Va.; $75,000 for sewers. Houston, Tex.; $20,000 for sewerage, water-works, etc. Spokane Falls, Wash.; $183,000 county bonds. Sanford, Fla.; $100,000 for streets. Columbus, O.; $49,000 advertised for sale by the county auditor. Kirksville, Mo.; $38,000 for electric light and water-works.

ELECTRICAL.

Electric Light.—***Little Falls, N. Y.***—A contract for 80 arc lights on the streets has been awarded to W. F. Lansing at 27.4 cts. per light per night.

Cleveland, O.—Proposals of electric lighting for 1892 will be received Nov. 4 by R. R. Herrick, Director of Public Works.

Terre Haute, Ind.—The City Clerk has been instructed to advertise for bids for lighting the city for three years. The committee appointed to purchase the electric light works has reported that the company would sell either the city circuit or both the city and the commercial circuits, but would not fix a price until the committee should be given power to act. The committee has been given such power.

Rockford, Ill.—The Rockford Electric Light & Power Co. has a contract for 20 lamps of 2,000 c. p. for 1 year at $111 each, $106 for two years and $98 for 3 years.

Geneva, Ill.—A committee has been appointed to obtain subscriptions for an electric light plant for Geneva and St. Charles. R. W. Sanborn and P. T. Bartholomew are on the committee.

Glenwood, Ia.—A vote will be taken Nov. 3 on the granting of an electric light franchise to J. D. Paddock and L. W. Boehner.

San Bernardino, Cal.—The San Antonio Electric Light & Power Co., has commenced work in San Antonio cañon to develop the water power, and in January it expects to be ready to deliver light and power to order at Pomona, Ontario, San Bernardino and all towns in the valley for incandescent lights. The charge will be 1 ct. per hour, and only for the hours the lights are actually used.

Companies.—Munsie-Coles Electric Railway Equipment Co., of Jersey City, N. J.: J. F. Munsie, T. L. Coles and R. H. Sherwood, $50,000. International Electric Mfg. Co., of Chicago, Ill.; E. T. Brainerd and Thomas E. Rushbrook, $100,000. McLeod Electric Mfg. Co., of Brooklyn, N. Y.; J. N. McLeod, $3,000. Niagara Power Co., of Buffalo, N. Y.; to use electricity from the water power tunnel plant; C. A. Sweet, Wm. Hamlin and F. D. Locke, $40,000.

CONTRACTING.

Street Work.—***Roanoke, Va.***—The contract for macadamizing has been awarded to W. F. Patterson, of Kenova, W. Va.; excavation, with material deposited within 2,000 ft., $1 per cu. yd. for solid rock, 33 cts. for shale and 25 cts. for earth; filling in soft places, 18 cts. per cu. yd.; gutter paving, 40 cts. per cu. yd.; 6 in. and 12-in. macadam, 32 cts. and 67 cts. per cu. yd.

Rip Rap.—***Newport, R. I.***—The following proposals have been received by Major Livermore, U. S. Engineer Office, for work at Fort Adams, including furnishing and placing rip rap granite and raising a portion of the west sea wall, the prices being, per ton of 2,000 lbs., respectively: James T. Cashman, New London, Conn., $1.62 and $2.87; Humphrey Toomey, Guilford, Conn., $2.10 and $5; Wm. H. Molthrop, New London, Conn., $2.50 and $3.20; C. T. Derry & Co., Boston, Mass., $2.89 and $5.74.

Tunnel.—***Seattle, Wash.***—The following proposals have been received by the Board of Public Works for the Lake Union sewer tunnel: J. G. Nelligan, excavating and lining with brick, $29.25; lining, $13.80, vitrified brick 50 cts. additional; excavating and concrete, $29 per ft. M. Brannigan, excavating, $10 per ft; lining, brick, $9.50; cement, $7.50; excavating and lining, brick, $19, cement, $17. Moran Bros., excavating and concrete lining, $16.80; excavating and brick lining, $27 per ft.; excavating and lining with concrete faced with brick, $16.80.

Iron Work.—The contract for the iron work of the machinery hall, the largest building of the Columbian Exposition, has been awarded to Binder & Seifert, of Chicago, Ill., at 3.698 cts. per lb.

Dredging.—The following proposals for $75,000 worth of dredging at Ocracoke Inlet, N. C., were received Oct. 20 by Capt. W. H. Bixby, U. S. Engineer Office, Wilmington, N. C.: Alabama Dredging & Jetty Co., Mobile, Ala., 17 cts. per cu. yd.; American Dredging Co., Philadelphia, Pa., 30 cts.; Moore & Wright, Portland, Me., 31 cts.; P. Sanford Ross, Jersey City, N. J., 34 cts.; C. T. Caler, Norfolk, Va., 41 cts.

Bridge and Approaches.—*New York, N. Y.*—The following table gives the prices of the proposals received by the Department of Public Parks for the construction of a bridge over the Harlem River at 155th St., to take the place of the existing Central or Macomb's Dam bridge and in connection with the viaduct now being built on the same street. The items of work are as follows:

1. Dredging at Pier I., and for crib fenders, measured in scows; per cu. yd.

2. Steel pneumatic caissons, complete in place for Piers I. and II., and including excavation of all kinds not otherwise provided for, concrete filling and masonry up to mean low water, the volume of material to be paid for being computed by area of caisson multiplied by distance from cutting edge to mean low water; per cu. yd.

3. Coffer dam and excavation for Pier III., including pumping, freezing and masonry up to mean low water, together with refilling, the volume of material to be paid for being measured by inside area of sheeting multiplied by average depth of dam from mean low water; per cu. yd.

4. Land pier excavations within area of sheeting, together with refilling; per cu. yd.

5. Piling of land piers, driven and cut off in place, piles 40 ft. or under when cut off for caps; per pile.

6. Piling of land piers, driven and cut off in place, piles 40 to 60 ft., when cut off for caps; per pile.

7. Yellow pine timber in grillages of land piers, per M. ft. B. M., including iron.

8. Crib-fenders stoned complete in place, and including the square timbered work above low water; per cu. ft.

9. Yellow pine timber sheathing of fenders, and all timber bracing and planking, including iron and bolts of all kinds; per M. ft.

10. Masonry, Piers I. and III., from mean low water to base of watchman's houses; per cu. yd.

11. Masonry, Pier II., from mean low water; per cu. yd.

12. Masonry, Piers IV., V., VI. and VII., from surface of platform to top of coping; per cu. yd.

13. End pedestals above coping, including stone newels, Piers IV., V., VI. and VII.; per cu. ft.

14. All exposed dressed surfaces, moldings, copings, weatherings, arrises, bridge seat stones, &c. (but not including work in pedestals and newels covered in price per cu. ft. for same); per sq. ft.

15. Watchmen's houses on ends of Piers I. and III. complete for each house.

16. All steel and iron in draw span, excluding rail-box and cornice; per lb.

17. All steel and iron in turntable and girder work below bottom chords of main trusses, including vertical shafts with lower pinion only attached thereto, with rack; per lb.

18. All steel and iron work in fixed spans, excluding rail-box and cornice; per lb.

19. All ornamental work, as specified.

20. Machinery of draw span complete, including engines, boiler, water tank, hydraulic rams and operating plant, horizontal shafting, beveled gears, hand gears, steam and hydraulic brakes, adjustable wall bearings on rest piers, capstan heads for hand turning, with levers, end locks, etc.

21. Flooring, casing and fitting up engine room complete, with coal bin, stairways, work bench, and all conveniences specified.

22. Railing, with intermediate newel posts, and including rail-box and cornice on draw span; per lin. ft.

23. Railing, with intermediate newel posts, and including rail-box and cornice of fixed spans; per lin. ft.

24. Single light lamps on draw span, with posts or brackets for each lamp.

25. Cluster lamps, posts and lamps; each.

26. Asphalt sidewalk; per sq. yd.

27. Asphalt roadway; per sq. yd.

28. Cast iron gratings over chord space of draw span; per lb.

29. Gas pipe main, through rail-box, including branches, connections, drips, and storage tank on draw span; per lin. ft.

30. Entire coat of paint, if required.

31. Removing present Central or Macomb's Dam bridge, with maintenance of travel.

The time stipulated for the completion of the whole work, according to these specifications, is 500 consecutive working days.

Items.	Quantities.	Pennsylvania Steel Co.	King Iron Bridge & Mfg. Co.	Passaic Rolling Mill Co.	Hart, Anderson & Barr.	Union Bridge Co.	Drake & Stratton.
1	7,400 cu. yds.	1.75	1.75	1.75	.50	1.98	1.00
2	4,289 "	37.00	39.00	40.00	40.00	29.12	27.50
3	2,225 "	19.00	25.00	20.00	25.00	16.17	25.00
4	1,800 "	1.50	3.00	1.00	3.00	2.26	10.50
5	200 piles	8.00	11.00	8.00	7.00	8.64	12.50
6	600 "	13.00	13.00	12.00	8.00	12.36	15.00
7	86,000 ft. B. M.	45.00	45.00	45.00	40.00	36.67	45.00
8	58,540 cu. ft.	.05⅛	.07	.06¼	.04	.651	.175
9	130,000 ft. B. M.	45.00	45.00	45.00	40.00	40.78	45.00
10	2,500 cu. yds.	24.50	24.00	25.50	26.00	21.33	30.00
11	1,000 "	23.00	24.00	24.50	16.00	19.06	25.00
12	3,450 "	26.50	29.50	26.25	28.00	22.37	27.50
13	2,800 cu. ft.	2.25	2.25	2.00	2.50	2.30	3.00
14	17,000 "	.90	1.00	.89	2.00	.86	1.00
15	.....	1,700.00	1,500.00	1,650.00	1,500.00	1,785.00	1,800.00
16	2,419,000 lbs.	5.05	5.10	4 99	4.30	4.85	5.96
17	750,000 "	8.20	6.10	6.50	6.70	6.60	10.51
18	1,360,000 "	4.60	4.80	4.82	4.03	4.25	4.67
19	.....	2,245.00	2,500.00	2,000.00	1,500.00	1,060.00	2,245.00
20	.....	14,950.00	16,000.00	16,500.00	16,000.00	14,800.00	14,800.00
21	.....	2,250.00	2,500.00	2,500.00	2,250.00	2,250.00	2,500.00
22	824 lin. ft.	21.50	21.50	24.50	25.00	25.00	21.50
23	630 "	15.62	15.62	14.00	14.00	15.00	15.62
24	64 lamps	55.00	55.00	30.00	30.00	25.00	55.00
25	8 "	125.00	125.00	275.00	300.00	250.00	125.00
26	1,690 sq. yds.	4.35	4.25	4.25	3.50	3.95	3.95
27	3,300 "	6.25	6.15	6.20	4.00	5.65	5.65
28	25,500 "	.052	.04	.05	.03	.04	.04
29	1,500 lin. ft.	1.55	1.55	1.75	.50	1.00	1.55
30	.....	4,500.00	3,000.00	2,500.00	2,500.00	2,000.00	1,700.00
31	.....	4,000.00	4,000.00	3,500.00	6,000.00	5,000.00	6,000.00
	5,404,320	885,536.00	842,116.30	818,159.85	780,721.80	724,049.80	925,018.00

PROPOSALS OPEN.

Levees.—About 150,000 cu. yds., about 18 miles south of Helena, Ark., to sublet to parties having outfits; principally sandy material and through fields. Oliver Ferguson & Son, Friars Point, Miss.

Road.—Etna and Sawyer's Bar wagon road. The Clerk of the Board of Supervisors of Siskiyou Co., Yreka, Cal. Oct. 28.

Bridge.—Across Corte Madera creek, near the present draw bridge of the San Francisco & North Pacific R. R. To consist of a draw span with trestle approaches. Width of bridge, 20 ft.; length over all, 416 ft.; clear openings of draw, 33 ft. across deepest portion of present channel of creek. T. S. Bonneau, Clerk of the Board of Supervisors of Marin Co., San Rafael, Cal. Nov. 10.

Water-Works.—*Colfax, Wash.*—About 2,840 ft. of 4 in. pipe, 13,992 ft. of 6-in., 4,216 ft. of 8-in., 3,512 ft. of 10-in. 3,000 ft. of 14-in. sewer pipe, 38 gates, hydrants, 4,635 lbs. of specials, reservoir of 500,000-galls. capacity, supply well and receiving basin, pumping plant of 1,000,000-galls. capacity. L. T. Bragg, Chairman of Fire and Water Committee. Nov. 5.

Lighting.—*Cleveland, O.*—Street lighting for 1892; electricity or gas. R. R. Herrick, Director of Public Works. Nov. 4.

Materials.—At Marine Barracks, Mare Island, Cal. Lumber, nails, iron pipe, galvanized pipe, brick, lime, sand, etc. Major H. B. Lowry, Q. M., U. S. Marine Corps, Washington, D. C. Oct. 30.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works, of Philadelphia, Pa., are building 10 mogul engines for the Canadian Pacific; cylinders 18 × 24 ins.; driving-wheels, 5 ft. diam.; weight, 48 tons; they are for the division east of Montreal. The Rhode Island Locomotive Works, of Providence, R. I., are building 25 engines for the Boston & Albany. The Richmond Locomotive & Machine Works, of Richmond, Va., report that they had a fire Oct. 15, which was quickly extinguished, and practically the only damage done was to the roof of the foundry, but full operation even in this department was only interrupted for a day or two. They are in better position for prompt and satisfactory work than ever before.

Cars.—The following companies have orders from the Lake Shore & Michigan Southern: Barney & Smith Mfg. C., of Dayton, O., 20 passenger cars; St. Charles Car Co., of St. Charles, Mo., 20 passenger cars; Laconia Car Works, of Laconia, N. H., 10 passenger cars; Peninsular Car Works, of Detroit, Mich., 500 box cars and 500 coal cars; Wells & French, of Chicago, Ill., 500 box cars and 300 platform cars.

Car Heating.—The Safety Car Heating & Lighting Co., of New York, N. Y., has completed the equipment with its steam heating system of the last of the 200 cars for the New York, New Haven & Hartford R. R., and is rapidly applying its hot water circulating system to the cars of the New York & New England R. R., in connection with which the Gibbs coupler is used.

Pipe Couplers and Steam Appliances.—In consequence of numerous applications for its apparatus for heating mills, street car houses, large buildings, and manufactories the Consolidated Car Heating Co. has established a new department, under the supervision of Mr. Edwin A. Smith, Assistant Secretary. The Commingler, which operates any hot water heating system, circulating with 2 lbs. or less of steam pressure and through many hundred feet of pipe, is to be a special feature of this new department. The Whitehall tunnel ditches on the Delaware & Hudson Canal Co.'s railway are kept free from ice in winter by a commingler circulation through 2,000 ft. of pipe, and the Albany Electric Ry. car house has 3,500 ft. of pipe in which hot water is circulated by the commingler. The McElroy steam coupler is already used in mills and manufactories, and its sale for various manufacturing purposes will also be a feature of the new department. The tightness of the McElroy coupler and its adaptability for a quick connection and disconnection has been practically demonstrated by several years' car-heating use on the Erie, Ontario, Lehigh Valley, Delaware & Hudson, and other railways. Special steam fittings and the automatic temperature regulator will also be furnished. The company will supply material and necessary blue prints and drawings to house-heating and manufacturing concerns, but will not do the work of application.

Well Drilling Plant.—Hardesty, King & Somers, of Mitchell, So. Dak., are said to have placed upon the market an improved artesian well machine, the invention of two Mitchell mechanics. It has several advantages over other machines while combining those peculiar to the old pole tool machine, the rotary hydraulic jetting process, and the cable and walking beam machine.

The Milwaukee Bridge & Iron Works plant, at Milwaukee, Wis., has been purchased at assignee's sale by Julius G. Wagner, for $30,000. Mr. Wagner has been engaged in the manufacture of architectural iron work, and will continue the manufacture of bridges.

The Berlin Iron Bridge Co., of East Berlin, Conn., has received the contract for the new blacksmith shop for the Dixon Mfg. Co., of Scranton, Pa. The building will be in the form of an L, 60 ft. wide by 235 ft. long, constructed entirely of iron.

The Carson Trench Machine Co., of Boston, Mass., has had plans prepared for a machine shop and office building at Charleston, Mass.; one story, 22 × 115 ft. with a boiler house wing 10 × 14 ft.

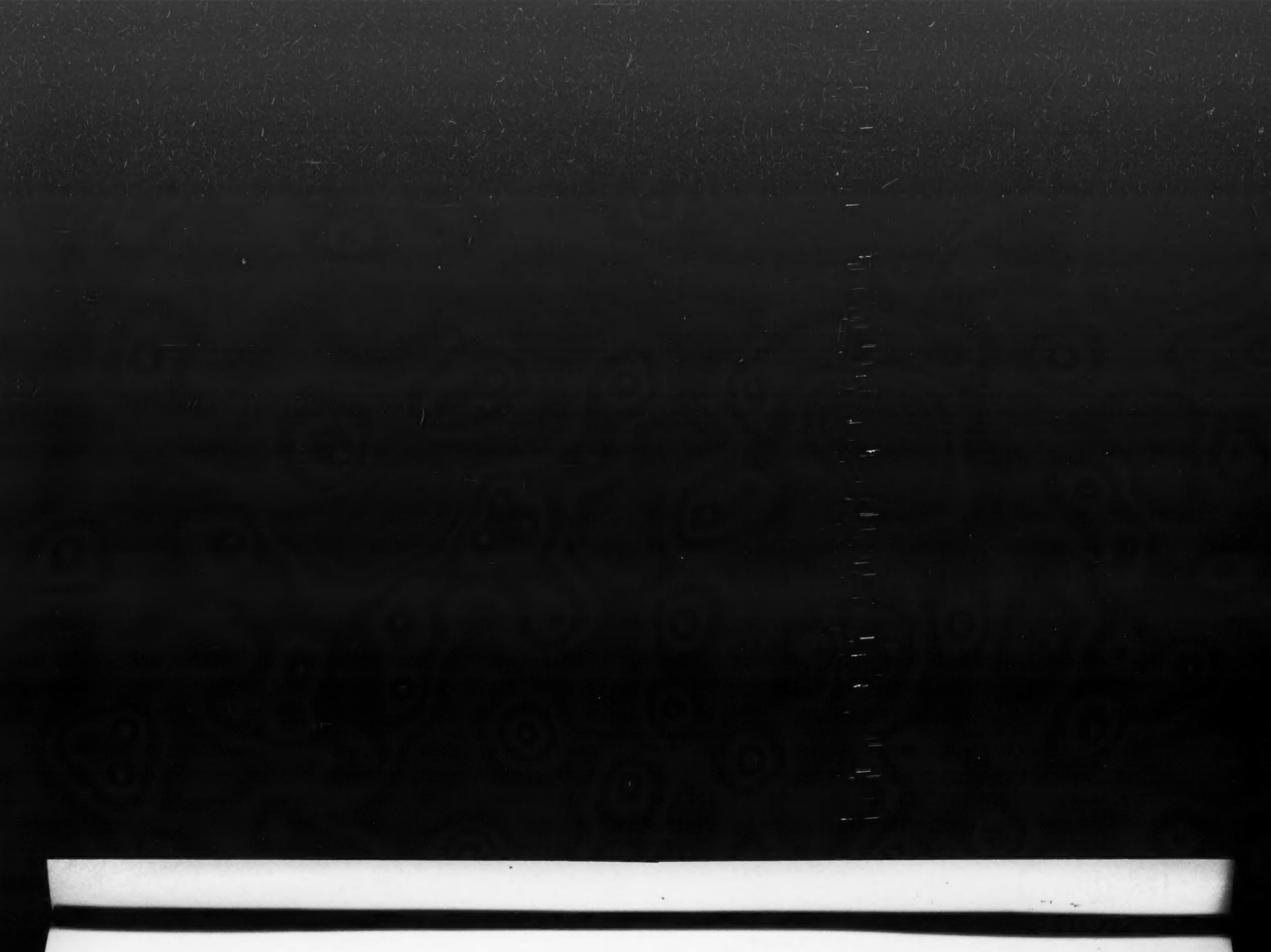
Companies.—Lenhart Mfg. Co., of Brooklyn, N. Y., to manufacture an automatic backwater and sewer gas valve to keep the gas out of buildings; N. L. Cocheu, P. F. Lenhart and P. J. Kennedy; $100,000. West Coast Construction Co., of Portland, Ore.; W. G. Steele, G. N. Holcomb and L. N. Ekland; $500,000. Northwestern Construction & Improvement Co., of Des Moines, Ia.; E. A. Temple, of Des Moines; J. A. O'Keefe, of Omaha, Neb.; S. H. Mallory, of Chariton, Ia.; $500,000. Ocala & Silver Springs Development Co., of Ocala, Fla.; Secretary, J. L. Gilfillan, and General Manger, H. C. Dean, both of New York; $1,000,000.

Metal Market Prices.—*Rails.*—New York: $30.80 to $31; old rails, $21 for iron and $16.50 to $17 for steel; girder rails, $40. Pittsburg: $30; old rails, $23.50 to $24 for iron and $17.50 to $18.50 for steel. Chicago: $31.50 to $33; old rails, $21 for iron and $14 to $16 for steel.

Track Materials.—New York: steel angle bars, 1.75 to 1.9 cts.; spikes, 2.15 to 2.25 cts.; track bolts, 2.8 to 3 cts., with square and hexagon nuts. Pittsburg: splice bars, 1.75 to 1.85 cts. for iron or steel; iron or steel spikes, 2.1 to 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 with hexagon nuts. Chicago: splice bars, 1.85 cts. for iron, 2 cts. for steel; spikes, 2.2 to 2.25 cts.; track bolts, 2.75 cts. with hexagon nuts.

Pipe.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½ per cent. on black and galvanized butt-welded; 67½ and 55 per cent. on black and galvanized lap-welded. Casing, 55 per cent.

Foundry Pig Iron.—New York: $14 to $17. Pittsburg: $14.50 to $16.50. Chicago: $14.50 to $17.50.

Lead.—New York: 4.3 cts. Chicago: 4.35 to 4.4 cts. St Louis: 4.3 to 4.32 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.9 to 2.1 cts.; tees, 2.45 to 2.75 cts.; sheared iron plates, 1.95 to 2.25 cts.; steel plates, 1.95 to 2.15 cts. for tank, 2.2 to 2.3 cts. for shell, 2.45 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.6 cts.; universal iron mill plates, 2 to 2.05 cts.; sheared steel bridge plates, 2.15 to 2.2 cts.; refined bars, 1.8 to 1.85 cts.; steel plates, 2.05 to 2.1 cts. for tank, 2.15 cts. for shell, 2.4 to 2.55 cts. for flange, 3.9 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.05 to 2.1 cts.; tees, 2.6 to 2.7 cts.; universal plates, 2.15 to 2.2 cts.; sheared steel plates, 2.2 to 2.25 cts. for steel; steel plates, 2.4 to 2.6 cts. for tank, 2.75 to 3 cts. for shell, 3 to 3.5 cts. for flange; 5 to 5.5 cts. for firebox; boiler rivets, 4.25 cts.